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EDITORIAL.

UPON completing with the present issue the twenty-first volume of KNOWLEDGE, the duty again devolves upon us of offering our acknowledgments to the host of friends who have so kindly contributed to our columns during the year; and also our assurance that the vigorous child conceived in the fertile brain of Richard A. Proctor has attained its majority (in volumes though not quite in years), in perfect health and strength; and, further, that it enters upon its future full of promise, and confident, at least, that it will seek to deserve a continuance of that hearty support so freely accorded it in the past.

In presenting the customary announcement of some of the leading projects included in our New Year's work, we have first to say that the January Number will contain a beautiful drawing of Saturn specially drawn for us by Mons. E. M. Antoniadi, who will also contribute an article entitled "Considerations on the Planet Saturn"; and that further photographic plates are in our hands from Dr. Isaac Roberts. The spectroscopic results obtained during the recent solar eclipse will, of course, be fully considered in our columns as soon as they have been worked out; and Mr. Maunder is arranging for a continuance of the photographic studies of the lunar surface.

Much attention will be given during the next two or three years to meteorological and cometary astronomy, as these branches of our work are entering upon an important epoch. We have accordingly arranged with Mr. W. F. Denning to continue his interesting column of Notes on Comets and Meteors. The Face of the Sky will be limned each month by Mr. A. Fowler, who has conducted this column with so much care since the lamented death of Mr. Herbert Sadler. We hope the following writers will also be found among our astronomical contributors in 1899:—Miss Agnes M. Clerke; Mons. C. Easton; Mr. J. Evershed; Mr. J. E. Gore; Prof. E. C. Pickering; and Mr. W. Shackleton.

The Rev. Thomas R. R. Stebbing, who has been portraying the Karkinokosm during the year with such marked success, purposes to complete the general outline of the study in two more chapters, and then to add some touches of light and shadow to the picture in subsequent essays.

Sir Edward Fry and Miss Agnes Fry have written a monograph, which will appear in KNOWLEDGE during the year, on "The Mycetozoa, and some questions which they suggest." The articles on these very interesting organisms, which are referred neither to the plants nor to the animals, will be fully illustrated from drawings by Miss Fry.

Prof. Grenville A. J. Cole has formulated a new series of original geological papers under the general title of "Secrets of the Earth's Crust"; and arrangements are in progress for the appearance of a new series of original studies on the "Treatment and Uses of Anthropological Data," with the object of stimulating interest in a somewhat neglected subject.

Commencing with the January Number, Mr. J. H. Cooke will contribute a monthly column of Notes devoted to Practical Microscopy; and among further contributions may be mentioned a series of articles on Electricity; "Two Months on the Guadalquivir": an account of a recent ornithological trip in the south of Spain, by Mr. Harry F. Witherby; a sketch of the Great Pitch Lakes in America, illustrated with some fine photographs by Sir Benjamin Stone, M.P.; and further contributions from Mr. A. Vaughan Jennings, Mr. R. Lydekker, Mr. Alex. B. MacDowall, Mr. H. Snowden Ward, the Rev. A. S. Wilson, and other writers.

XUM

VOLCANOES OF THE NORTH.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

THE north-east corner of Ireland is eminently a plateau country. When we enter Belfast Lough from the sea, the irregular rounded hills of Down find a contrast on the western side in the broad-backed braes of Antrim. Dark cliffs of basalt can be seen high upon the slopes, with here and there a gleam of chalk beneath them. One or two deep valleys have been cut through the plateau by the streams that seek the sea; but the general crest is level, some one thousand one hundred feet above the water, until the whole mass dies away into a series of rounded domes, far away towards Moira in the south.

The conspicuous black scarp runs round the coast to Garron Point; it is broken on the back of the ancient gneiss of Torr; and then it reappears, in its fullest grandeur, between Ballycastle and the Giant's Causeway. We may follow it yet further, to the grim cliffs above the lowland of Lough Foyle; and then we may trace these southward up the Roe, to the noble heights above Dungiven and the tableland at Moneymore. Within this circuit of one hundred and fifty miles, the country is uniformly covered with basaltic rocks. They dip down towards the low-lying basin of Lough Neagh, but form rapidly rising moorlands as we move again outward from the water. Even on the western shore of the lake, where their width is only some five miles, the basalts find room for the production of the characteristic uplands, clothed with gorse and heather.

The plateaux thus cover almost all the County of Antrim, and an important part of the County of Londonderry; but the scarped nature of their outer edge shows that they must have formerly extended further. On the east, the flat top of Scrabo Hill, near Newtownards, recalls the features of the plateaux; and inspection shows that we have here a thick mass of basalt, protecting the soft red sandstones of the district. This hill is nine miles from the main scarps above Belfast. On the west, again, there is a remarkable outlier on the northern summit of Slieve Gallion, one thousand five hundred feet above the sea, from which the hillside falls rapidly on all sides. We look away from it westward, across a wild country, worn out of the older rocks, and can picture the basalt as stretching on in old times, until it met the rim of its basin in the very heart of Donegal.

It is little wonder that such broad expanses of uniform rock, lying in beds, tier upon tier, with an obvious tendency to weather out as plateaux, were compared by many older geologists with regularly stratified aqueous deposits. The type of scenery common in County Antrim is thus repeated among the limestone hills of Sligo, a district of inland scarps and massive tablelands; and most of us are familiar with such features in the stratified Pennine Chain of England. Werner, reasoning from the isolated sheets of basalt in central Germany, asserted that such rocks were precipitated from solution in water; and his views obtained a remarkable hold upon men who were content to make theories, rather than to undertake laborious observations. These "Neptunian" doctrines were part of a system which, as Lyell quaintly remarks, "had not the smallest foundation, either in Scripture or in common sense,"* and were refuted by Werner's French contemporaries, Guettard, Faujas de St. Fond, and Desmarest. Faujas, in his fine folio work,* attributes much of his information to an elderly cleric, the Abbé de Mortesagne, whose enthusiastic and picturesque letters are printed in full. In another letter we find M. Ozy, a chemist of Clermont-Ferrand, attributing his own enlightenment as to the volcanic nature of his country to the visit of "Olzendorff," an Englishman, and "Bowls," an Irishman, who came out in 1750 to study the lead mines of Auvergne. May we not presume that the "M. Bowls" was acquainted with Antrim and the Giants' Causeway, and found in the perfectly preserved craters round the Puy de Dôme the verification of opinions formed in Ireland?

The matter has more interest than would at first appear; for the earliest printed appreciation of the volcanic origin of the Irish basalts seems to be contained in the second edition of a highly speculative work, by John Whitehurst, published in 1786. Whether "Olzendorff" or "Bowls" was the direct instructor of M. Ozy, the views propounded by them from the summit of the Puy de Dôme were extremely novel in 1750.† The "Irlandois" was probably the William Bowles who wrote a treatise on Spain in 1776, and whose mineral collection is known to have been sold in 1830.

The story of the struggle against the Wernerians, and of the ultimate triumph of the supporters of volcanic action, is well told by Portlock.‡ The Liassic shale of Portrush in Ireland has been baked by intrusive sheets of dolerite, and has come to resemble the compact basalt of the district. Its fossiliferous character made the Wernerians hail it as a basalt containing marine shells, and as an obvious proof of their contentions. Kirwan, who established the first important mineral collection in Dublin, supported this unhappy view. Playfair published the true explanation in 1802, before he had visited the district; but the error lingered on for another fifteen years. Even now, when the igneous origin of the plateau-basalts is everywhere accepted, questions arise as to the vent or vents from which such broad masses were erupted.

There is no doubt that the great mass of the basalts of north-eastern Ireland were poured out as lava-flows upon a terrestrial surface. Despite later faults and dislocations, the relation of the lower streams to this old land-surface can again and again be seen. In the beautiful sections along the Antrim coast, some of which are naturally cut and some due to quarrying, the following Mesozoic rocks appear in order:—Trias, Lower Lias, Upper Cretaceous. The basalts are found lying upon an eroded surface of Chalk, and occasionally overstep on to the Triassic sandstones, as they do at Scrabo Hill. A layer of reddened flint gravel constantly intervenes between the basalt and the chalk, representing the material that covered the surface, as a product of subaërial decay, before the eruptive epoch opened. We can picture, then, a country of low chalk downs, the dark beds of the Lias and the red-brown Trias occasionally showing in the valleys. Trees grew in sheltered places, and streams collected the flint nodules in their courses, washing them out of the general soil-cap of the country. In the great period of stress, which gave rise to the Pyrenees and the Juras, and ultimately to the Alpine system, the north of Ireland and the west of Scotland became broken by a series of fissures, up which molten lava flowed. These fissures remain to us as an amazing series of dykes, traversing the area in a

* "Principles of Geology," Vol. I. (1830), p. 69.

* "*Recherches sur les volcans éteints du Vivarais et du Velay*," Grenoble and Paris, 1778.

† *See* Sir A. Geikie, on Guettard and Desmarest, "Ancient Volcanoes of Great Britain" Vol. I., preface.

‡ "Rep. on Geol. of Londonderry, etc." (1843), pp. 37-44.

north-westerly and south-easterly direction. The great Cleveland dyke, which cuts the Jurassic strata of Yorkshire, must be included among them; and outlying members occur about Lough Erne, and even in the County of Galway. Sir A. Geikie* estimates that the "dyke-region embraces an area of upwards of forty thousand square miles—that is, a territory greater than either Scotland or Ireland, and equal to more than a third of the total land surface of the British Isles." This, however, is but a small matter, compared with the whole region involved in the volcanic activity of early Cainozoic times. Suffice it that, as a detail in the general overflow, the downs of Antrim and Londonderry became buried in successive lava-flows.

Even the advocates of "fissure-eruptions," as a means of flooding a whole province with lava, now regard the molten rock as flowing from a number of points along the track, each centre resembling an ordinary volcanic vent. The flows coalesce in the hollows, mount upon their predecessors, spread now this way, now that, and eventually

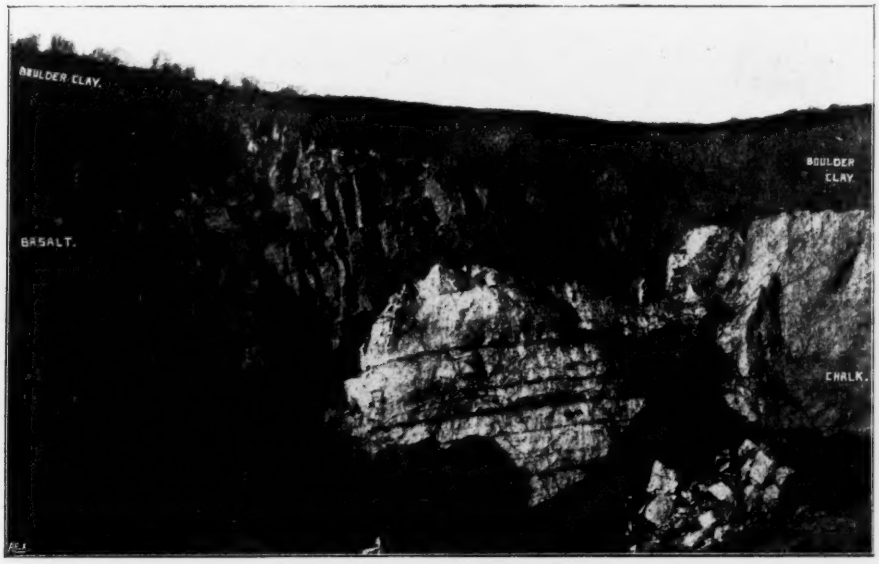

FIG. 1.—Columnar Basaltic Lava-flow, resting upon old land-surface of denuded Chalk. Quarry at Whitehead, Belfast Lough. Typical Section in the Antrim Plateaux. The lava has been subsequently denuded, and boulder-clay has been deposited across the whole. Photographed by Mr. R. Welch.

obliterate all the features of the landscape. New vents may break through this rudely stratified accumulation, and may sometimes build up true scoria-cones on the surface, as their action becomes more irregular and explosive. A country deluged with lava from small "puys," like those on the central plateau of France, may finally come to possess a few isolated volcanic mountains, from which the last products are ejected. When all dies down, when denudation works its will, the separated cones are all but swept away. Perhaps their mere necks, filled with crystalline lava or with coarse agglomerate, remain standing out above the earlier fields of lava. Then the latter become cut into by the streams; the buried landscapes are in places restored to light; while the masses left between the newly cut valleys have the form of table-lands and plateaux, capped by the relics of the flows.

In our northern volcanic area these successive events can be followed out. While many of the dykes never reached the surface, others may easily have been responsible for the basaltic flows. Olivine-basalts and basaltic andesites, sometimes retaining a glassy structure in their ground-work, sometimes of almost doleritic texture, cover the irregular surface of the chalk. Their lower portions have often become columnar, where they contracted on cooling in contact with the loose flint gravels (Fig. 1). The separate lava-streams can be traced out in the great cliff-sections, and are seen to dovetail into one another, each great basaltic "stratum" being formed of several adjacent and overlapping flows. Steam-bubbles, globular in form, or elongated by the flow of the molten mass, or strikingly irregular, are everywhere in evidence, especially near the surfaces of the flows. In many cases, white nests of zeolites, chalcedony, or opal, have formed within them, and probably began to fill up the cavities as soon as the lavas came to rest. Often the upper part of a flow is rubbly and irregular, while the lower part, which cooled more slowly, has assumed a bold columnar structure, so that the flow appears at a distance to consist of two distinct types of lava. This feature is conspicuous on the bold headlands round the Giant's Causeway; and the Causeway itself is the basal portion of a stream of similar character.

The Giant's Causeway owes its fame to the exquisite regularity of its columnar structure, and to the neatness of its curving cross-joints. The east coast of Skye, or the cliffs of Loch-na-Keal, in Mull, may produce nobler volcanic landscapes; while the isolated relic of a massive lava-flow, now forming the Isle of Staffa, is far more wild and picturesque. But the district of the Giant's Causeway must always remain as a perfect museum for the student, and the black dykes that jut out into the water are as characteristic in the landscape as the flows themselves.

The majority of the dykes that are revealed in the fine series of sections along the scarps of Antrim cut through both the chalk and the lower lava-flows. They form black and often sinuous bands, traversing the quarry-faces; and their mere abundance is in the highest degree impressive. The lava-flows that may have been connected with their rise have often been entirely swept away. But we have clear evidence that pauses occurred in the activity at various points, for the lava-sheets that remain are often separated by bands of red earth, which are the products of the weathering of one flow before the next was poured out across its surface. These layers, well known also among the black cliffs of Skye, form striking lines of colour in the sections. The broad red band, running along the cliffs east of the Causeway, cannot fail to strike every visitor, and points to a time of general rest throughout the district. By its means, as exposed here and at other places, the eruptive series has been divided into two stages;

* Work quoted, Vol. II., p. 121.

and the dykes that cut this ferruginous zone can safely be referred to the upper basaltic stage.

This period of quiet must have been, indeed, a long one. Lakes were formed, and forests grew, on the crumbling surface of the earlier flows. Red and brown nodular iron-ores, like those still forming in the lakes of Sweden, are quarried above Glenarm from between the lower and upper lavas. Clay-beds, with numerous plant-remains, occur here and in other places; and bauxite, a sediment rich in aluminium hydrate, forms a valuable ore of aluminium. The pale colour of the bauxite, unlike that of the bauxite of southern France, suggests that it was derived in this case from volcanic rocks rich in alumina but poor in iron; and a very suggestive conglomerate occurs in association with it near Glenarm. A stream of the quiet period seems here to have washed down pebbles of white and decomposing rhyolite, a lava rich in silica, and far removed in nature from the basalts. A centre of rhyolitic eruption probably lay at no great distance; and at Templepatrick and Tardree, in the neighbourhood of Antrim town, we have clear proofs of the invasion of rhyolite into the lower basaltic series.*

The eruption of dark basic matter seems, indeed, to have been successfully interrupted, and the contents of another reservoir of molten rock penetrated locally through the the surface. In writing of the Mourne Mountains,† we have shown how the granite in that area is probably of Cainozoic age, and how it truncates one series of basic dykes, and is itself cut by a second series. The rhyolites of Antrim almost certainly belong to the same epoch, and have a similar chemical composition. A few cones were reared locally upon the devastated surface of the country, and their white flanks and vitreous lavas must have contrasted strangely with the earlier basalts, which were now reddening and decaying all around them. Denudation, however, made short work of these little cones, and their relics were subsequently buried under the upper series of the basalts. Their products now appear, thanks to later weathering, in some force around Tardree, which is one of the most interesting volcanic districts in the whole of the British Isles.

Though Sir A. Geikie regards the group of rocks here exposed as entirely intrusive, the great variety of glassy lavas that occur on the plateau of Sandy Braes seems to indicate volcanic action at the surface. We have no need to go to Lipari or to Hungary for specimens of red fluidal rhyolites, or spherulitic pitchstone, or black perlitic obsidian. While the main layer of obsidian has broken up into isolated blocks, which are decomposing into yellow sand, a fragmental rock hard by, formed of pumiceous particles and blocks of compact brown rhyolite, seems to be a true tuff, and to indicate explosive action. Down at Ballypalidy, a little to the east, rhyolitic fragments, as has often been pointed out, occur in beds of iron-ore among the basalts; and the locality, like Glenarm, has become famous by the abundance of associated plant-remains.

These remains, preserved in the deposits of a period of repose, are unfortunately all that we have to guide us as to the age of the whole series of eruptions. Formerly, the flora was regarded as Miocene, and the close resemblance between the sequence of volcanic phenomena in Antrim and in Auvergne in the Miocene period makes the suggestion tempting to the petrographer. But Mr. Starkie Gardner, who has dealt with the whole evidence from Ireland, Mull, and even further north, has decided in favour of placing the leaf deposits as far back as the early Eocene. The scenery of our district in Eocene times was thus in strange contrast to that of the London and Hampshire basins; but the Cleveland Dyke, crossing England beneath the surface, shows how nearly the peace of eastern lands was threatened.

When the upper basalts spread across the country, new centres of eruption were set up. Intrusive masses penetrated all the earlier rocks, and came here and there to the surface as volcanic necks. The one striking object among the inland plateaux of County Antrim is the huge mass of Slemish, one thousand four hundred and thirty-seven feet above the sea, which forms so conspicuous and strange a feature above the basaltic moorland. This sheer ridge of rock is composed of dolerite, rising through the earlier lavas; and doubtless at one time a great cone of volcanic material lay about it. At Carnmoney, near Belfast, a far smaller neck breaks through the Mesozoic strata, and another rises as a dome-shaped mass above the romantic valley of Cushendall. At Carrick-a-rede, and at other points upon the Causeway coast, necks full of "bombs of basalt, with pieces of chalk and flint," point to more violent phases of eruption.* Though nothing like a true cone or crater remains in the whole Irish area, disguised though the details may be by the effects of denudation and post-Eocene earth-movement, we cannot doubt the cumulative evidence as to the volcanic origin of the landscape.

We still must send our students to Auvergne—or to Catalonia, if they prefer it—to see how a few puys may deluge a whole land with lava. But the wonder with which we look across our great moorlands of the north will not be diminished by the comparison. The far blue crag of Slemish, standing out in the clear highland air, will only become associated for us with days stranger and more distant than those in which St. Patrick pastured his sheep beneath its wall.

* *See* Sir A. Geikie, work quoted, Vol. II., p. 205; and G. Cole, "Rhyolites of the County of Antrim," *Sci. Trans. R. Dublin Soc.*, Vol. VI. (1896), p. 105, &c.

† KNOWLEDGE, Vol. XXI., p. 123.

CHRISTMAS CUSTOMS OF SHAKESPEARE'S GREENWOOD.

By GEORGE MORLEY,

Author of "Leafy Warwickshire," etc.

THE first signs of the approaching custom of "keeping Christmas" may be observed as early as the middle of October in the parlour of many a rustic cot in leafy Warwickshire. In the wide and warm inglenook (and the ingle is still to be met with in sundry cottages and farmsteads of this stationary greenwood) a small pyramid of sawn log-wood may be seen standing to dry, and in the middle of the room, or in a recess, the great green or yellow marrow is suspended by gay-coloured ribbons from a hook in the rafter—the recipient of many admiring glances, and many wishes for a slice out of it when it shall be served as a Christmas dish.

As the stuffed chine of pork is, among the peasantry of this greenwood, the customary sign observed at the mothering, so the ribbon-decorated marrow is one of the symbols of the Christmas custom. The marrow is grown to a giant size (the larger the more honour to the grower, and the more plentiful the feast), is hung up in the house-parlour until the eve of the festival, and is then prepared and stuffed.

Another custom preparatory to the great feast of the year is the gathering of crabs, and the stewing of them for a winter dish. In this we have an ancient custom,

* Sir A. Geikie, work quoted, p. 277; see also *ibid*, p. 271.

handed down for at least three hundred years, and in use at the end of the nineteenth century.

Shakespeare was evidently well acquainted with the crab-lore of his native woodland, for not only does he make Caliban say, in "The Tempest" (Act ii., scene 2):—

"Let me bring thee where crabs grow,"

but in the well-known lines:—

"When roasted crabs hiss in the bowl
Then nightly sings the staring owl,
To-who;
To-whit, to-who, a merry note,
While greasy Joan doth keel the pot."

he alludes to this very winter dish, the annual making of which is a welcome custom to many a rustic housewife in the poet's own neighbourhood to this day.

The custom of "the Thomasing," though not now (in its old state) so prevalent as formerly in the out-of-the-way villages and hamlets of Warwickshire, is still in extensive use in a new guise and under newer methods. "Goin' a Thomasin'" is literally going begging for Christmas gifts.

Similar in design to the custom of the "Maying," the rule at the Thomasing (which, as its name implies, was always observed on St. Thomas's Day) was to make a circuit of the villages in procession, and with a little rustic song at the door of cottage, farm, and hall, to bring the greetings of the festive season to the inmates, and to plead for gifts with which to "keep Christmas"; a plea which was, and is, seldom disregarded by the kind-hearted farmers and county people, despite contrary seasons, increased rates and taxes, and falls in prices.

Perhaps the prettiest part of the custom which is now synonymous with the old Thomasing is that in which the homely carols are sung at the doors of the larger village houses. In the silences of the dark greenwood (for the carolling is chiefly performed at night) the voices of the singers, many of whom are choristers of the parish church, sound peculiarly attractive; and the very quaintness of the rhymes and the tune (which are of their own making) materially enhance the effect.

One Christmas night, a few years since, I heard the carollers raising their voices through the dim and silent woodland and caught the words of their rhyme, which were as follows—sung to a lilting, swaying tune, which, owing to the scene and time, had something sweet, and yet strange, about it:—

"Little Cock Robin sat on a wall,
We wish you a Merry Christmas
And a great snowfall;
Apples to eat
And nuts to crack,
We wish you a Merry Christmas
With a rap, tap, tap."

When a repetition of the "rap, tap, tap" is executed as a finale to the verse, the doors of the houses are knocked, and the plea for Christmas gifts made and responded to. Their gifts secured, the dim and quiet landscape rings with the verses of the beautiful Christmas hymn, "While Shepherds Watched their Flocks by Night," given by the singers as a sort of thank-offering for value received.

As it was formerly the custom at the ingathering of the corn-harvest to commemorate the event by duologues in costume, so at the Christmas feast in each year a band of Warwickshire peasants was wont to appear in the farmsteads and perform various acts of mummery to the assembled company. The mask and the mummer, however, are now seen only at rare intervals in the farm kitchen; and what, in the past, was a decidedly picturesque entertainment (formed and carried out by the humbler folk for the delectation of their betters) has now been taken up by the betters themselves; and in "The Hall" of most villages in Shakespeare's greenwood it is the custom to organize theatricals and pieces of mummery, and perform them before aristocratic guests from Christmas Day to Twelfth Night.

Though their mummeries are now things of the past, the rustics still number among their customs the venerable one of bringing in the Yule-log. It would be surprising if it were not so, in a county where the sered and wasted remnants of the ancient Forest of Arden stand around in such variety and abundance—ready grown for the axe and the hand of the woodlander. The peasant for his cottage parlour, the farmer for his spacious kitchen, and the squire for his stately hall, vie with one another in securing the largest, the firmest, and the dryest log for the Christmas hearthstone: each according to his requirements and the size of the fireplace in their respective domiciles.

With the humbler true-born native of Shakespeare's greenwood, whose mind is still overlaid with a cloudy texture of superstition, any wood will do for the yule-log but the wood of the wych elm. This must never be burnt in the house for fear "the old 'ooman," who is thought to inhabit that tree, should come down in vengeance upon those who dare to desecrate and destroy her branches. It used to be the custom to preserve a piece of the previous year's brand with which to light the log.

Though not so greatly in vogue, as in the days of the Squire Cass of "Silas Marner," the drinking of glasses of elder wine on Christmas morning is still observed with unfailing regularity in many isolated cots by the wood or on the waste; and if the morning be winterly it is a "cup that cheers."

With the passing of the Christmas festivities and the arrival of New Year's Eve, the musical dwellers of leafy Warwickshire again go in procession to the doors of the village houses and sing their greetings (in the dark and stilly night) to the occupants of cottage, farm, and hall. If only on account of the quaintness of their rhymes, the custom of "singin' the New Year in" deserves to be preserved, and some record kept of the lines used for the occasion; especially so as there is a likelihood that it may become rarer each year owing to the change of manners even in rural districts.

For five years I have not heard the carollists singing their New Year's greetings; but on New Year's Eve in 1893 I chanced to be on the skirts of a village and came upon a group trilling the following quaint lines:—

"The roads are very dirty,
My boots are very thin;
I have a little pocket
To put a penny in.
God send you happy,
God send you happy,
Praise the Lord to send you all
A Happy New Year."

"God bless the master of this house,
God bless the mistress true;
And all the little children,
Around the table, too.
And send you a Happy New Year,
And send you a Happy New Year;
God bless you all,
Both great and small,
And send you a Happy New Year."

Sung in the last hour of the last day in the year, and in the silence of a dim green world where men thin away to the utmost insignificance, these quaint and homely lines of blessing for friend and neighbour (sung in a befitting minor key), form an appropriate ending to the year's customs of Shakespeare's greenwood; a county so rich in

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historic, poetic, and romantic associations, in traditions and legends, in folk-lore, customs, and dialect, that, turn whichever way you will, something new and interesting is invariably to be found.

THE COLOURS OF COWRIES.

By R. Lydekker.

AMONG all the treasures of the shell-cabinet few are more generally attractive than the cowries, or kauris (*Cypræa*), which form the type of a family by themselves. Rivalling the olives in the brilliancy of their polished enamel, they exceed those shells in the beauty and diversity of their coloration, while their form in the adult state is so peculiar as to attract the attention of even the most unobservant. Possibly, the very fact that many of them, like the tiger and Surinam-toad cowry, are so common as to be employed as decorative objects for our chimney pieces, has, to a certain extent, detracted in popular estimation from their many striking peculiarities. But even if this be so, a moment's comparison with any other shell will at once show how different they really are. And if rarity be an additional attraction, some, among the couple of hundred or so of living species, are worthy of attention even from this not very elevated standpoint. Take, for instance, the prince cowry (*C. princeps*) and the spotted cowry (*C. guttata*), examples of which have sold respectively for forty and forty-two pounds each; while the beautiful orange cowry, used as a head ornament by the chiefs of the Friendly Islands, formerly fetched about twenty pounds, although good specimens can now be bought at from three pounds to five pounds. Other species claim attention on account of their commercial uses, the ring cowry being employed by the islanders of Eastern Asia for personal adornment, for weighting their fishing nets, and as a means of exchange; while in the latter respect the well-known money cowry has a still more extensive use over a large part of Asia.

But it is from the peculiarities of their structure and coloration that these beautiful shells must claim our attention in the present article. Taking any common species, such as the one shown in the centre of Fig. 1, it will be seen that the upper surface of the shell approaches more or less to an egg-shape, with a notch at each extremity forming the terminations of the mouth below. Somewhat to the right of the middle line in most species runs a straight or slightly sinuous streak over which the pattern of the rest of the upper surface does not extend, this line marking in the living animal the limits of the right and left lobes of the so-called mantle, which during activity extend upwards from the foot on which the creature crawls to envelope the rest of the shell. Compared with an olive, in which it is relatively small, the shell of an adult cowry differs by the almost or complete absence of a distinct spire; while on the under surface the narrow mouth of the shell (not, be it understood, of the animal) is remarkable for the series of vertical ridges, or "teeth," with which its edges are armed.

Now, since almost all other univalve shells related, even remotely, to the cowries, have a more or less elongated spire at the hinder or upper end, the enquirer naturally seeks to find out the reason for the disappearance of this part in the members of the present group. In a fully adult specimen of the common black-spotted tiger cowry no trace at all of the spire can be detected, but in the equally common Surinam-toad cowry a more or less distinct remnant, partly buried in the abundant cement, is observable even in the adult. In Scott's cowry, of which an adult specimen is shown in the centre of Fig. 2, the spire is much more pronounced; and in a half-grown specimen of the same species (left side of the same figure) it is so elongated as to project considerably beyond the hinder extremity of the shell. The same specimen also shows that in immature examples of this species the hinder extremity of the right margin of the shell is expanded into a wing-like extension, recalling the wing-shells, or *Strombidæ*. In both the adult and the young of Scott's cowry the coloration is very similar; but in the young shell shown on the right of Fig. 2, which belongs to the Surinam-toad cowry, there is a difference both in form and in colour from the adult. In form the shell has a distinct spire, and a thin outer lip; and if a still younger example were selected it would be found that these characters were still more exaggerated, the mouth being entirely devoid of teeth, and the outer lip quite thin and sharp. Moreover, whereas the upper surface of the adult shell has a broad dark brown margin, and the central area spotted with light brown on a ground of dark brown, the young exhibits dark and light transverse bands, with a certain amount of mottling.

Young cowries, then, are much more like ordinary shells than are the adult, and clearly indicate that the latter belong to a highly modified or specialized type. The alteration is produced by the expansion of the mantle-lobes of the adult, which deposit a shining enamel over the entire shell, eventually concealing, more or less completely, the spire, and thus totally modifying the original form. A young cowry is, indeed, much more like an olive or a melon-shell; but, as a matter of fact, neither of the two latter are the nearest relatives of the *Cypræidæ*, among which are the *Strombidæ*, or wing-shells. And in this connection the near resemblance of the young of Scott's cowry (Fig. 2, *a*) to a wing-shell is decidedly worthy of note, as suggestive of a direct affinity between the wing-shells and the cowries.

Turning now to the interesting problem of coloration, the first feature that must attract the attentive observer is that the striking pattern developed on the shells of most cowries is seldom seen by the animals themselves, for the reason that by the time the creature is fully protruded from its shell, the upper surface of the latter is more or less completely concealed by the fleshy lobes of the mantle. Accordingly, it would seem to be apparent that the colouring of these molluscs is developed for the purpose of protection, and not for the admiration of the different individuals or sexes of the same species. It might, indeed, be urged that as the lobes of the mantle are coloured similarly to the shell, or even more intensely, the colours are visible to the animals, and are therefore designed for mutual admiration. But had this been the object, it would surely have sufficed to restrict the coloration to the outer surface of the mantle-lobes, and not to have extended it on to their inner surfaces, from which it is deposited on the shell. As regards the utility of the cowry type of coloration for protective purposes, I have never enjoyed the opportunity of seeing the living molluscs in their native haunts, nor have I come across any description from those who have. Cowries, which are mostly tropical or sub-tropical animals, are, however, described as living in shallow water not far from the shore, and feeding on zoophytes; and, so far as one can judge, their colours ought to harmonize well with the hues of the denizens of a coral-bank, or a mass of sea-anemones, many of which are more or less similarly spotted. If this explanation prove to be the true one, we can readily see why both the shells and the hard parts of cowries partake of the same striking types of coloration.

Turning now to the consideration of the various types

of coloration met with among cowries, it may be mentioned, as a preliminary, that among mammals spots and stripes are frequently met with in the young which disappear in the adult. Many species of deer and swine, for instance, which are spotted or striped with white in youth become more or less completely uniform in mature age; while the lion and the puma frequently exhibit traces of dark spotting in the cub stage. In these animals, therefore, it is evident that a spotted or striped coat is the original type, and a uniform tint the more advanced form. In cowries, on the other hand, it seems that transverse dark banding was the original type of coloration, and that from such banded type two later modifications have taken place. In the one of these, spotting of various kinds has resulted, while in the other a more or less uniform colour has been the final result. The primitive banded type serves to connect the cowries with less specialized shells, a young Surinam-toad cowry being strikingly like a melon-shell, both in form and colouring, while the faint banding observable in young specimens of Scott's cowry recalls the colours of many of the wing-shells, to which, as already mentioned, the former approximates in form.

The proof that banding was the original type of cowry coloration is easy, seeing that it obtains in the young of the great majority of species. Fig. 2, *b*, exhibits the striped stage of the Surinam-toad cowry, which, in the adult, as already said, has chestnut spots on a dark ground in the central area of the upper surface. In Fig. 3, *a*, are shown the adult and immature conditions of the common lynx cowry, the former of which is variously spotted, while the latter still retains distinct transverse dark and light bands. Still more striking is the difference between the immature and adult conditions of the lesser false Argus cowry, as shown in Fig. 4, the latter exhibiting small white spots on a dark ground, while the former is banded with dark and light, without the slightest trace of spotting. It will be observed that this species of cowry is of a long narrow shape, and it would seem, for two reasons, probable that that is the primitive form of cowries; the short and broad shape, as shown in Fig. 1, *a*, being a later modification. One of the reasons in favour of this view is that almost all cowries which retain the primitive banding in the adult condition are of the long form. Among such may be mentioned the little wasp cowry (Fig. 3, *b*), the mole cowry (*C. talpa*), remarkable for its tawny back and dark brown base, and one variety of the carnelian cowry (*C. carneola*), as well as the orange-tipped cowry (*C. isabella*). Again, in the true Argus cowry (Fig. 6), which develops peculiar ringed spots in the adult condition, the primitive bands are still more or less distinctly traceable at all ages.

To exemplify the second reason for the same view, we may take the serpent's-head cowry, of which the adult is shown in Figure 1, *a*. Here we see the short round type in its full development, the coloration being chocolate brown above and below, with the central area of the back finely spotted with white. If, however, we take a young individual of this species, it will be noticed that the shape of the shell is comparatively long and narrow, while the colouring is in the form of bands. Many other instances might be cited, but the foregoing are sufficient for my present purpose.

I may accordingly pass on to notice briefly some of the more striking types of coloration presented by adult cowries, and here I must deplore the circumstance that editorial commands restrict the number of illustrations to my article.* Banded cowries have been already mentioned, but it may be added that, from the intensity of the colours, the wasp cowry (Figure 3, *b*) is not improbably the culmination of this type. On the other hand, in the flesh-coloured carnelian cowry, of which there is both a long and a short form, the bands tend to become very indistinct; and it may be suggested that the short form is not far removed from the ancestral type of the beautiful orange cowry, which is one of the few uniformly coloured species; such uniformly coloured forms indicating, as already said, one line of specialization.

Among the spotted cowries several types are noticeable. Firstly, we have species in which the back of the shell is simply spotted with black or brown, among them being the tiger cowry (*C. tigris*), the panther cowry (*C. pantherina*), and the much smaller lynx cowry (*C. lynx*). As all these have a comparatively short and wide shell they indicate an advanced type. Next, we have white-spotted cowries, such as the false argus (*C. cervus*), the lesser false argus (Fig. 4), and the fallow-deer cowry (*C. vitellus*); and as the two former are long-shaped, while the latter is comparatively short, they seem to indicate a medium stage of evolution.

From the black- and brown-spotted types seem to have originated another group represented by the map and nutmeg cowries (*C. mappa* and *arabica*, Fig. 5), in which the spots are retained along the margins of the back of the shell, the central area of which is more or less finely reticulated or vermiculated, the map cowry taking its name from the width and sinuosity of the line between the mantle lobes. In the typical nutmeg cowry the reticulations are very nutmeg-like, but in other specimens more or less distinct pale spots are dotted all over the central area, till in the variety *histrio* (Fig. 1, *c*) the spots are the dominant feature, being only separated by thin lines, so as to form a kind of network, or honeycomb arrangement. Perhaps the colander cowry (Fig. 3, *c*) may be regarded as an offshoot of this type.

But another modification may apparently also be traced to the *arabica-mappa* stock, the members of which are intermediate between the long and the short types. As already said, these cowries have the central area of the back reticulated or white-spotted, and lighter than the black-spotted margin. And from such a type the transition is easy to the modification presented by the serpent's-head cowry (Fig. 1, *a*), and the Surinam-toad cowry, in which the central area is white- or chestnut-spotted, while the margin and much of the under surface is dark brown. The great width and shortness of these cowries afford further evidence of their high degree of modification. Obviously the chestnut-bordered cowry (Fig. 1, *d*) is another member of this group in which chestnut spots have been superadded to the normal white-spotted central area. Apparently a special development of this type may be recognized in the white ring cowry (*C. annulus*), the yellow ring from which it takes its name marking the line of division between the original spotted central area and the dark area. Finally, from the ring cowry may easily be derived the money cowry, in which the ring has all but disappeared, while the marginal area has developed a series of rugosities, apparently connected with the filaments on the margins of the mantle lobes, which scarcely intrude on to the central area. Whether these two white species have a habitat different from that of their brethren is a subject well worth the investigation of those who have the opportunity.

Omitting mention of certain other sub-types on account of limitation of space, this part of the subject may be concluded by brief reference to the true argus cowry (*C. argus*, Fig. 6), which, from its elongated form and the retention of barring, is evidently an ancient type specially distinguished by the ring-like form of the spots.

* I am indebted for the photographs from which these illustrations were taken to Mr. N. M. Richardson, of Monte Video, near Weymouth.

All the above-mentioned species (together with a host of others) are members of the typical genus *Cypræa*, distinguished by the smooth and shining enamel, and the circumstance that the teeth of the mouth do not extend across the whole of the lower surface, as shown in Fig. 1, *d*. There are, however, other cowries differing from these by the development of rugosities on the back, and the extension of the teeth of the mouth right across the lower surface. Both these features may safely be regarded as indications of greater specialization than exists among any of the typical cowries. One type is represented by the pustuled cowry (Fig. 1, *b*), in which the ornamentation on the upper surface takes the form of small spherical pustules, frequently of a bright red colour, when they recall a fragment of wood overgrown with fungi. In the second, and still more advanced modification, the ornamentation of the back assumes the form of transverse ridges, which in some species (Fig. 1, *e*) are comparatively wide apart, and separated by a considerable interval in the middle line, whereas in others, like the little European cowry (*Trivia europæa*), they are so closely approximated, and so nearly meet in the middle line, as to give the idea of a small and neatly-parted head of hair.

Even these by no means exhaust the modifications which the cowry type is capable of assuming, as witness the pure white "poached egg," and the "weaver's shuttle," both members of the genus *Ovula*, and the latter remarkable for the elongation of the two extremities of the mouth into tube-like processes. Both these, as well as certain other allied types, depart from the ordinary cowry type by their white or pinkish colour, and are therefore evidently specialized modifications. In the case of the weaver's shuttle the colour is probably produced to harmonize with the sea-fans, upon which these molluscs are parasitic; but further information in regard to the reason for the absence of colour is requisite in the case of the other kinds.

One result of the necessarily brief dissertation on cowries is to show how short-sighted was the idea prevalent some years ago that the shells were of no importance in the study of molluscs, and that attention must be restricted to the soft parts (the so-called "animal") alone. A wider grasp of the subject shows that nothing in Nature is unworthy of our best attention, and is sure to yield results of more or less absorbing interest if only we approach the subject with unbiassed and unprejudiced minds.

REFERENCES TO PLATE.

FIG. 1.—*a*. Serpent's-head Cowry (*Cypræa caput-serpentis*). *b*. Pustuled Cowry (*Pustularia pustulata*), upper and under views. *c*. Histrio Cowry (*C. arabica histrio*). *d*. Chestnut-bordered Cowry (*C. helvola*), upper and under views. *e*. Radiate Cowry (*Trivia radians*).

FIG. 2.—*a*. Scott's Cowry (*Cypræa scotti*), young and adult. *b*. Surinam-Toad Cowry (*C. mauritanica*), young.

FIG. 3.—*a*. Adult and Immature of Lynx Cowry (*Cypræa lynx*). *b*. Wasp Cowry (*C. asellus*). *c*. Colander Cowry (*C. cribraria*).

FIG. 4.—Immature and Adult conditions of the Lesser False Argus Cowry (*Cypræa exanthema*).

FIG. 5.—Nutmeg (*a*) and Map (*b*) Cowries (*C. arabica* and *mappa*).

FIG. 6.—The Argus Cowry (*Cypræa argus*).

Notices of Books.

A Classification of Vertebrata. By Hans Gadow, M.A., F.R.S., etc. (A. & C. Black.) 3s. 6d. net. The extent to which knowledge increases in all departments of scientific study is nowhere more impressively brought home to one than in the changing classifications which these advances make necessary in the domains of biology. Of course, the practical aim of any system of classification is sorting and grouping; and the ideal system is one which expresses briefly all that is known of the race history and development of the creatures dealt with. To mitigate the discrepancies as much as possible, chiefly owing to the bewildering mass of fossil reptiles which have come to light, Dr. Gadow has "arranged the reptiles in numerous sub-classes, and these again in orders, while for the host of fishes 'divisions,' and for the birds 'divisions' and 'legions' have been resorted to as intermediate groups between sub-classes and orders." An interesting table on p. 61 accentuates in the most marked way what has been said about the necessity of elaborations in systems of classification which are not very recent. The table shows there are, in all, some twenty-four thousand two hundred and forty-one recent species of vertebrate forms to be arranged; of these, nine thousand eight hundred and eighteen are birds, and two thousand seven hundred and two, mammals. The fishes number no fewer than seven thousand three hundred and twenty-eight.

Krōmscōp Colour Photography. By Frederic Ives. (London: The Photochromoscope Syndicate, Limited.) The problem of reproducing in permanent form the colour of objects is a popular one. Many attempts at solving it have been made, with varying amounts of success, but none of them have been successful in obtaining coloured prints of natural or artificial objects. Three processes which have up to the present gone farthest in this direction are:—(1) The process of Prof. Lippman, by means of which beautifully coloured photographs are obtained on glass by interference effects. (2) Prof. Joly's process, in which an object is photographed through a glass, having fine lines closely ruled upon it, coloured in the primary colours. The colourless picture thus obtained is afterwards projected through a similar glass, with the result that the colours are reproduced. (3) The Krōmscōp of Mr. Ives, by which three negatives are taken through three glasses coloured with the primary colours. These negatives are afterwards combined in one picture. The colours of an object are thus first analysed and then synthesised. This method gives excellent results, and is the only one which has so far been successfully placed on the market. The little booklet which Mr. Ives has written gives full particulars concerning the construction and method of using his instrument, and with the various appendices, which comprise expressions of opinion on the theory of colour by several physicists, should be useful in popularizing his method of reproducing natural colours.

Stories of Starland. By Mary Proctor. (Potter and Putnam Company, New York; G. W. Bacon & Co., Ltd., London.) Miss Proctor has written a very delightful little book on astronomy for children. "I like it awfully" was the verdict of one small boy upon it. Very simply and clearly she tells—or, rather, her little brother Harry elicits from her—the principal facts about what we see in sun and moon and sky in the daytime or at night. Very many stories and legends, such as are told by the Indian and Australian peoples, are mixed up with the sterner facts of scientific astronomy, and some of these are not generally known, whilst the rest will bear repetition. The story of the meteor that was claimed by the landlord as flying game and the tenant as ground game, the Custom House authorities intervening, ought to be true if it is not really so. In a book for children the illustrations might have well been rendered more numerous than they really are. It was a pity, too, to insert "the moon" on page 50, and we must confess that we fail to recognize the aspect. Perhaps, too, the fearfully complicated system of canals on Mars, represented on page 71, might with advantage have

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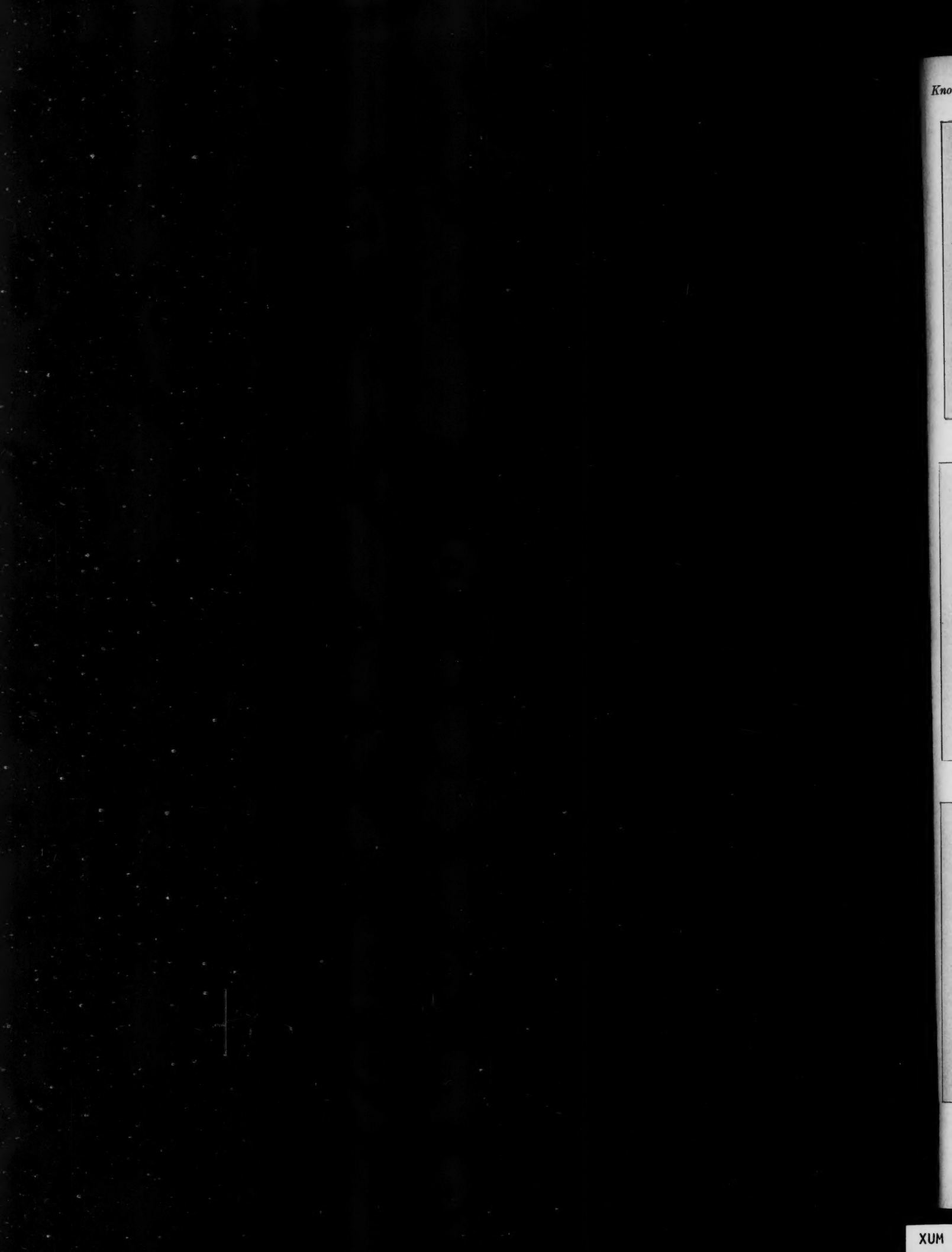

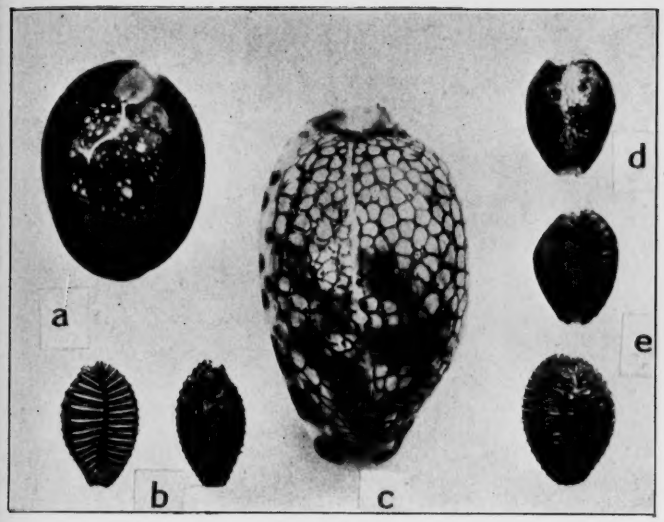

FIG. 1.

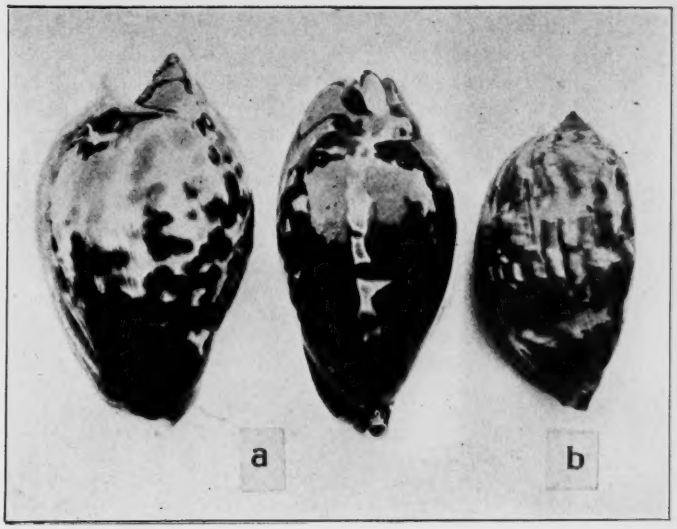

FIG. 2.

FIG. 3.

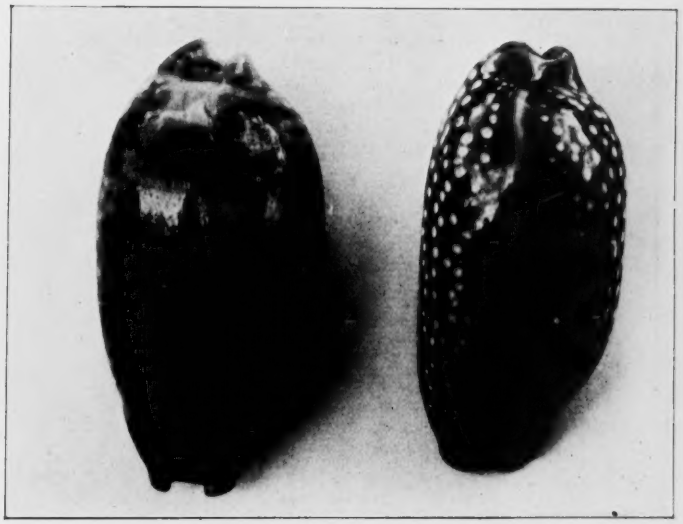

FIG. 4.

FIG. 5.

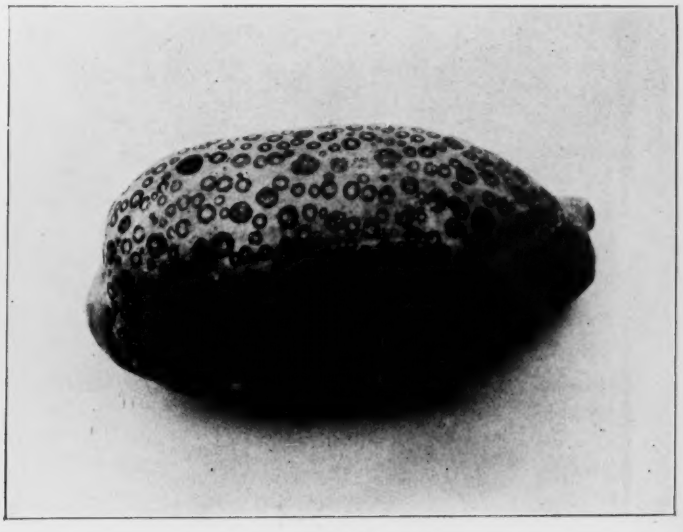

FIG. 6.

THE COLOURS OF COWRIES.

For Description of Illustrations, see page 272.

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been left altogether to the imagination of the children, or, at least, relegated to the legends. The "scenery on the moon," on page 52, rather mystifies children, as the craters are shown from a lunar standpoint, and they fail to see "how the photographer got there." But all these belong to the first part of the book. The second part, telling the stories of the summer and winter stars, are extremely good —well written and well illustrated—and should lead many of the children of this generation to consider the heavens.

Geology for Beginners. By W. W. Watts, M.A., etc. (Macmillan.) Illustrated. 2s. 6d. As Secretary of the British Association Committee on Photographs of Geological Interest, Prof. Watts has had exceptional opportunities of obtaining good pictures for his work on geology. A glance through this charming little volume affords the fullest evidence that he has availed himself of his position. No book on the market, at the modest price at which the publishers have issued this introduction to a most fascinating subject, compares with it in its profusion of beautifully reproduced original illustrations. In the three hundred and thirty-nine pages, there are no fewer than three hundred and nine illustrations. Each chapter is provided with a concise summary and a carefully graduated set of questions which should prove of great service to teachers. Beginning with the familiar and easily observed aspects of the earth, Prof. Watts takes the pupil along pleasant roads, by easy stages, to those more difficult subjects which are best studied in the laboratory. But, with the instincts of a true teacher, each difficulty is cleared up as it is encountered; and we have no hesitation in saying that the student who works conscientiously through this book will find himself equipped with a working knowledge of geology which will not only help him in understanding the problems of Nature but will provide him with a new pleasure in life. The index is more complete than any we have seen in an elementary work.

The Studio. This magazine, devoted to art, abounds in illustrations so excellent that they alone render it a remarkable shilling's-worth. The art enlarged on and illustrated embraces a wide area. We are charmed with designs of pots and book-covers, or instructed in all varieties of brush and pencil work, while artists of Japan, as well as samples of the schools of the Continent and of England, are before us. It may be to this breadth of purpose that a lack of definite instruction is to be traced. We should certainly like to see a vigorous dealing with some of the art absurdities of our day, but whether mediævalism outdone, as in "Decoration for a Library," or truly classic beauty, the "Studio" loves all art, and all who are called artists, in its pages.

English National Education: a Sketch of the Rise of Public Elementary Schools in England. By H. Holman. (The Victorian Era Series: Blackie & Son.) 2s. 6d. This is an admirable sketch of the history of a great subject, and its author is to be congratulated upon the skill in compilation which has enabled him to present a vast mass of detail without submerging the main purpose of the book. That it is yet overweighted with much ineffective detail in the shape of a long array of projects unfulfilled must be admitted, yet it is an interesting and instructive study to follow the main lines of the case against popular education, which remained practically the same throughout, but which crumbled steadily away so soon as its supporters were forced to give their reasons, and it was reserved for Sir Charles Adderley to furnish the most insane argument in defence of the lost cause. Mr. Holman has paid an eloquent tribute to the services of Sir James P. Kay-Shuttleworth, the first secretary of the Committee of Council for Education, "a post for which he was probably by far the best qualified man in the country"; and he has also generously commended the labours of Mr. Arthur H. Dyke Acland, a recent Vice-President of the Council. "Of the work of Mr. Acland it would be difficult to speak too highly, for he has probably studied more, worked more, and suffered more for the cause of education than any other non-educationist (in the technical sense)." This testimony will only confirm the widespread regret among the friends of education at the impending retirement of Mr. Acland from the House of Commons. It is in the main a sorry story which Mr. Holman has to tell of wasted time, wasted money, and wasted opportunities, which will not bear reflection in its relation to the present day keenness of the struggle for the world's markets. A supreme Council of Education was set up in Prussia in 1787, and an elementary school law was adopted in Upper Canada in 1816; while in the mother country it was shown in the Report of a Royal Commission rather more than thirty years ago, that more than eight hundred thousand children, out of a total of one and a half million scholars, were attending schools which were notoriously inefficient. What might not Britain's position have been now if a little common sense had entered into the solution of the education problem a hundred years ago. Mr. Holman's book is certainly disfigured by ungenerous references to Matthew Arnold and to Owen, as well as by an imperfect index; but for directness of aim as a continuous narrative of the facts it is a valuable addition to the series.

Outlines of Vertebrate Palæontology for Students of Zoology. By Arthur Smith Woodward. (Cambridge University Press.) Illustrated. 14s. To rightly understand the varied problems which the study of zoology presents, the student who has mastered the elementary parts of his subject must not only acquaint himself with the facts of embryology but should also enter somewhat minutely into the past history of life on the globe. Hitherto this has not been an easy task, necessitating as it did references to, and a search among, many books and serials dealing with other subjects as well, but Mr. Smith Woodward, by the publication of his book, has abolished these trying and time-occupying experiences. He has brought together, in rather more than four hundred pages, all the facts which the student is likely to require. The more important points and generalizations are alone printed in large type; purely technical and descriptive information is set forth in small type. The classification adopted is mainly that of the British Museum Catalogues of Fossil Vertebrata, but where the recent progress of research has made it desirable, certain modifications have been adopted. The text is accompanied by two hundred and twenty-eight illustrations, a fair proportion of which are original. The final chapter of the book is given to a general sketch of the whole subject from the geologist's point of view, and in it Mr. Woodward rightly insists that, "owing to the imperfection of the geological record and the incomplete exploration of most formations, any statement now formulated may eventually prove to be quite a partial account of the facts, and every conclusion must be more or less provisional and tentative." Several other limitations are clearly set forth and deserve to be widely known. Mr. Woodward's book will be of real service to students of zoology and geology.

SHORT NOTICES.

Poultry for the Table and Market versus Fancy Fowls. Third Edition. By W. B. Tegetmeier, F.Z.S. (Horace Cox.) Illustrated. 2s. 6d. Mr. Tegetmeier is a veteran in the art of poultry rearing. Nearly forty years ago he published a book on profitable as distinguished from fancy or ornamental poultry. The County Councils have availed themselves of reprints from pages of this work for in-

struction in technical education, a fact which stamps the work as authoritative. Housing, feeding, hatching, rearing chickens, diseases of poultry, and fallacies of poultry farming, are among the many items dealt with, and the present edition has been made more useful by including an account of the mode of raising turkeys in the open.

Outlines of the Earth's History. By Nathaniel Southgate Thaler. (Heinemann.) Illustrated. 7s. 6d. The author states in the preface to his book that most other text-books lead the student to believe that Nature's workings have ended, "rather than something is endlessly doing," and that the present condition of the earth is stationary instead of being a stage in an unending procession of events. That such notions are erroneous may be proved by noting the imperceptible change wrought in a certain place during a space say of twenty years, especially in a volcanic district. The method of putting out in interesting sentences the history of our planet will commend itself to the reader who desires amusement combined with instruction. The author endeavours to prove that the changes which have taken place on the earth during the many million years in which our planet is supposed to have existed, are always going on, and will do so until the end. The book seems a clear exponent of the agencies which are involved in the mutations of our planet, and may be recommended as good reading for all interested in natural phenomena.

Ackworth Birds. By Major Walter B. Arundel. (Gurney & Jackson.) This is a list of one hundred and forty-nine species of birds observed in the district of Ackworth, Yorkshire. The author has divided the book into four parts, dealing with permanent residents, regular summer residents, regular winter residents, and visitors. The local names of the birds are given, as well as a brief description of the habits of each species. The book will be of little interest save to those who live in the district. Whether or no the book contains a complete list of the birds which have been observed in the district we must leave to those well acquainted with Ackworth to judge.

The Birds of Montreal. By Ernest D. Wintle. (London: Wheldon & Co.) This is a similar book to the preceding one, and deals with two hundred and fifty-four species of birds observed in the vicinity of Montreal. The author has published this list, which is the work of fifteen years' observation, "with a view to induce others to publish lists of birds occurring in various districts of the Province of Quebec, which would give us a better knowledge of the avifauna of the province, as some species occur and breed in only certain sections of it." Some sporting sketches, compiled by David Denne, are printed at the end of the book.

Radiography. By R. T. Bottone. (Whittaker & Co.) Illustrated. 3s. A welcome addition to the literature on radiography. The book does not call for much comment, but it may be safely recommended to those who desire to have by them a trustworthy account of the steps that have led up to the discovery and application of the so-called X-rays. It is lucid and accurate, all the statements made by Mr. Bottone, as may be expected, having been verified by personal experiment. Instructions are given for constructing X-ray apparatus, and the subject matter is brightened by excellent photographs of the results obtained in this absorbing branch of science.

Applied Geology. By J. V. Elsden, B.SC.(Lond.). (The "Quarry" Publishing Co.) Part I. 5s. This unpretentious little book is part of a series of articles still appearing in the "Quarry." Practical works on geology are scarce, and therefore Mr. Elsden's book will be all the more acceptable. The price is rather high for such a slim volume, but the matter more than compensates for this otherwise prohibitive figure. Mr. Elsden has made it his study to bring together problems which confront the practical geologist, and he gives ample rules and graphic methods for their solution. Rules, for example, for calculating the thickness of strata, calculation of true dip by formulæ and by graphic construction, and he also marshals many facts from allied sciences into a form peculiarly adapted to the geologist concerned in the development of the mineral resources of the earth.

The Unconscious Mind. By Alfred T. Schofield, M.D., M.R.C.S. (Hodder & Stoughton.) 7s. 6d. Although this book is mainly a compilation from other treatises on similar subjects, students of mental physiology and psychology will find here much useful matter happily arranged in logical sequence. The many examples of phenomena from every-day life are undeniably interesting and instructive. The author, not without success, endeavours to put in a handy shape the more important literature of life and mind. The references at the foot of each page, and the list of works of reference given at the end of the book, testify to our author's diligent and steadfastness of purpose in endeavouring to render humanity service in the search for the source of conduct, of instinct, of tact, and the thousand qualities that make us what we are. According to Dr. Schofield the *unconscious mind* is the greater part of mind, consciousness being the illuminated disc on which attention is rivetted on account of its brightness, as if it were all, whereas in the shades around stretch mental faculties—deeper, wider, loftier, and truer.

The Fern World. By Francis G. Heath. (The Imperial Press.) Illustrated. 5s. Eighth Edition. The present edition of this well-known book has been thoroughly revised, and is now issued at a price within reach of the majority of book-buyers. Mr. Heath's picturesque descriptions of fern-life are enriched by the interpolation of coloured plates, which, since the last edition appeared, have been re-drawn. Many aspects of fern-life find a place in these pages—the germs, conditions of growth, classification, distribution, uses, folk-lore, and so on.

Carpentry and Joinery. By Fredk. C. Webber. (Methuen & Co.) Illustrated. 3s. 6d. Forms one of a series of works on technical science under the co-editorship of Dr. Garnett and Prof. Wertheimer. The subject is treated on practical lines, and includes geometry, carpentry, joinery and staircasing, and handrailing. The drawings are intended not only as illustrations to the text, but also as a guidance to the foreman in executing a piece of work which he has under control in his workshop. Mr. Webber, following the lead of many others, begins with geometry, and in twenty-five pages gives the student a glimpse of many branches of that complex science, about as much as can be learnt in one week's study. It is a great mistake to suppose this can be of any practical use to a skilled artizan. Fig. 16, p 13, cannot be drawn from the instructions given. The author is woefully deficient in literary ability; he apparently does not know how to distinguish between *letters* and the points and lines they represent.

We have on our table some beautiful specimens of fossils from the Middle Eocene—Barton, Hants—sent to us by Mr. R. Charles, a naturalist who has collected large numbers, particularly of Barton Mollusca, and, although not a dealer in the ordinary sense, he is prepared to supply collectors at the most popular prices. Each specimen is named, boxed, and located.

BOOKS RECEIVED.

From Matter to Man. By A. Redcote Dewar. (Chapman & Hall.) 3s. 6d.

Cressy and Poictiers. By J. G. Edgar. (Ward, Lock & Co.) Illustrated. 3s. 6d.

London in the Reign of Victoria. By G. Laurence Gomme. (Blackie.) 2s. 6d.

A Middle Algebra. By Wm. Briggs and G. H. Bryan. (Clive.) 3s. 6d.

The Renaissance of Girls' Education in England. By Alice Zimmern. (A. D. Innes & Co.) 5s.

The Groundwork of Science. By St. George Mivart. (Murray.) 6s.

The Encyclopædia of Sport, Vol. II., Leo-Z. Edited by the Earl of Suffolk and F. G. Aflalo. (Lawrence & Bullen.) Illustrated.

Elementary Text-Book of Botany. By S. H. Vines. (Sonnenschein.) Illustrated. 9s.

How to Avoid Tubercle. By A. T. Tucker Wise, M.D. (Baillière, Tindall & Cox.)

How to make Lantern Slides. By S. L. Coulthurst. (Dawbarn & Ward.) Illustrated. 1s. net.

The Story of Geographical Discovery. By Joseph Jacobs. (Newnes.) Illustrated. 1s.

A List of European Birds. By Heatley Noble, F.Z.S. (R. H. Porter.) 3s. net.

Handbook for Literary and Debating Societies. (Hodder & Stoughton.) 3s. 6d.

Practical Inorganic Chemistry for Advanced Students. By Chapman Jones. (Macmillan.) 2s. 6d.

Birds of the British Isles. By John Duncan. (Walter Scott.) Illustrated. 5s.

The Farmer and the Birds. By Edith Carrington. (G. Bell & Sons.)

Humane Science Lectures. Various authors. (G. Bell & Sons.) 1s.

Photograms of 1898. (Dawbarn & Ward.) 1s. net.

A First Algebra. By Dr. W. T. Knight. (Relfe Bros.) 6d.

The Story of the Cotton Plant. By F. Wilkinson. (Newnes.) Illustrated. 1s.

An Introduction to Practical Physics. By D. Rintoul. (Macmillan.) Illustrated. 2s. 6d.

First Stage Practical Inorganic Chemistry. By F. Beddow. (Clive.) Illustrated. 1s.

First Lessons in Modern Geology. By the late A. H. Green. Edited by J. F. Blake. (Clarendon Press.) Illustrated. 3s. 6d.

Chemistry for Schools. By C. Haughton Gill. (Stanford.) Illustrated. 4s. 6d.

Molesworth's Metrical Tables. (Spon.) 2s.

The Slide Rule. By R. G. Blaine. (Spon.) 2s. 6d.

Comparative Photographic Spectra of Stars to the Three and a Half Magnitude. By Frank McClean, F.R.S. (Dulau.) 7s. 6d.

Spectra of Southern Stars, with Tables and Plates. By Frank McClean, F.R.S. (Stanford.) 10s.

Science Notes.

Sir Clements Markham pleads urgently for funds for a national expedition to the Antarctic regions which, according to Sir John Murray, should be furnished with as much as one hundred thousand pounds, and towards this, we understand, the Council of the Royal Geographical Society have promised to head the list with five thousand pounds. It is to be feared that unless the more wealthy of our countrymen come forward with the necessary aid in undertakings of this kind our prestige as pioneers in voyages of discovery will be eclipsed by adventurers of other countries. Our own rich Government spends so much on powder and smoke that it cannot afford to extend a helping hand in matters of this kind. Mr. Cornelius Vanderbilt has generously fitted out an expedition to explore the flora of Porto Rico, and it is earnestly hoped that many rich men in this country may emulate his example by contributing to the fund which Sir Clements Markham and others so ardently desire for so laudable a purpose.

A Parliamentary blue-book on the Ordnance Survey has just been issued, and shows progress of that important work up to 31st March, 1898. We gather from the report that in 1899 there will be available to the public for the first time a *one-inch* outline map of the whole of the country, prepared on one uniform system, and with its principal details nearly up to date.

From the catalogue of Messrs. Johnson, Matthey & Co., Hatton Garden, London, we learn that "In furtherance of scientific research, professors and recognized scientific investigators will with pleasure be supplied with metals of the platinum group, in moderate quantities, and for periods to be arranged, free of charge, on condition that the precious metals are ultimately returned (in any form), and that the results of the investigations are furnished."

An expedition, the main purpose of which is to determine the vertical distribution of ocean life by a series of open nets, has been organized, and consists of Mr. George Murray, Mr. V. H. Blackman, and Dr. Gregory, of the British Museum; Mr. J. E. S. Moore, Dr. Sambon, and Mr. Highley, an artist, complete the staff of the expedition. Prof. Agassiz and his school contend that the oceanic fauna is confined to the surface and bottom belts and that the vast intervening zone is devoid of life. Sir John Murray and others hold that there is no such barren belt, and that the oceans are inhabited throughout their whole depth. The *Oceana* has been chartered for a short cruise, beginning work on the West Coast of Ireland, at the edge of the one-hundred-fathom platform. Continuous observations will be made with a chain of tow-nets till, when the depth reaches two thousand fathoms, the series will include thirty-eight tow-nets. Experiments with various forms of self-closing nets will be made for the sake of comparisons, and, if time permit, some deep-sea trawling will be done.

An expedition has been sent out to investigate the fauna of the island of Sokotra, about one hundred and fifty miles east-north-east of Cape Guardafui. Mr. W. R. Ogilvie Grant, of the British Museum, Dr. Forbes, of the Liverpool Museum, and Mr. Cutmore, a taxidermist, have sailed for Aden, where the Indian Marine guardship, *Elphinstone*, placed at the disposal of the party, will convey them to the island and back to Aden on the termination of their stay. The botany of Sokotra is fairly-well known owing to the visit made to it by Prof. Balfour in 1880, when he gave special attention to the flora; but from the zoological point of view the island is almost unexplored.

In France there are two villages completely lighted by acetylene. There are also ten factories engaged in the manufacture of the *carbide*, formed by the action of the electric current on a mixture of lime and coke dust, the reduced calcium combining with the excess of carbon. The resulting calcic carbide easily decomposes in presence of water and yields the powerful illuminant acetylene. The carbide in the States is produced by electric power derived from the Falls of Niagara, and similar means are employed at Neuhausen, Switzerland. The Schuckert Electrical Manufacturing Company, Nuremberg, will soon be able to turn out carbide sufficient to give two hundred million cubic feet of acetylene annually.

In the annual report which has just been published by the Meteorological Council, it is shown that during the last twelve months fifty-five per cent. of their forecasts were correct, twenty-six per cent. were nearly so, six were failures, and thirteen partially so. These failures were largely due to the fact that we do not possess observing stations in the Atlantic. The observers have no means of noting the approach of a depression until it is quite near the coast. It is something, however, to know the results are becoming more and more correct as the number of observatories where the distribution of atmospheric pressure and the direction of the wind are noted by skilled observers increases. In Ireland and the west and north of Scotland the forecasts are unsatisfactory, and will remain so till more stations are established on the Atlantic.

While the inhabitants of Great Britain consume eighty-six pounds of sugar per head, the Russians are credited with only eight and a quarter pounds. A recent official report states that the beet-sugar industry was carried on in Russia as far back as the year 1800. In 1897 the production of sugar in Russia was six hundred and forty-four thousand nine hundred tons, of which four hundred and eighty-four thousand tons were required for her own population; and in 1896 some one hundred and fifty thousand tons were exported to Europe, most of which, of course, found its way to London.

A very encouraging report of the analyses of sugar-beet grown at Romney Marsh, Kent, has been given recently by a firm of sugar refiners of Liverpool. Experiments, it appears, have been conducted at the place named under the cognizance of the Board of Agriculture, and the results tend to prove that the district is highly suitable for the sugar industry.

There were several interesting exhibits at the opening meeting of the Linnean Society. Prof. Howes showed the living eggs of *Sphenodon*, the remarkable lizard of New Zealand. This reptile is noted for the pineal eye under the skin in the centre of its forehead, as well as for its relationship to extinct forms; and the development which will now at last be worked out ought to prove of an interesting character. Some photographs were shown by Mr. Allan Crossman of his common buzzard and the large chicken which this bird of prey hatched and brought up. One remarkable point, apart from the triumph of maternal instinct, is that the buzzard has learned to eat the chicken's food, while the chicken shows a predilection for flesh, and will help its foster-mother to kill sparrows. The double tusk of an elephant, shown by the president, Dr. Günther, offered a problem as to whether it was a case of reduplication, or whether the milk tusk had not been shed and had persisted.

XUM

There is a generally accepted idea that metals have smells, since if you take up a piece of metal at random, or a coin out of your pocket, a smell can usually be detected. But Prof. W. E. Ayrton finds that as metals are more and more carefully cleaned, they become more and more alike in emitting *no* smell, and, indeed, when they are very clean, it seems impossible for the best of noses to distinguish any one of these metals from the rest, or even to detect its presence. The smell associated with metals, and hitherto regarded as being due to the metals themselves, is really due to the presence of some impurity, usually a compound of carbon and hydrogen. Much misapprehension has also prevailed with respect to the diffusion of smells. The passage of a smell is generally far more due to the actual motion of the air containing it than to the diffusion of the odoriferous substance through the air. If the breath is held, without in any way closing the nose either externally or by contracting the nasal muscles, no smelling sensation is experienced, even when the nose is held close to pepper, or a strong solution of spirits of hartshorn. Prof. Ayrton has also carried out experiments on the power of different substances to absorb various scents from the air, and finds that many of the old beliefs have to be exactly reversed. Thus, grains of natural musk lose their fragrance at a comparatively rapid rate when exposed to the air. The popular statement that a grain of musk will scent a room for years is, therefore, not supported by laboratory experience. The way in which some smells cling to various substances is very remarkable. No amount of rubbing would remove the smell of rose leaves from glass.

A French scientist has been making observations recently upon double-yolked eggs, a number of which were incubated for a certain time and then examined. In twenty per cent. neither of the yolks developed, but were found to be joined to one another by a considerable surface, and the germ discs or cicatriculæ were close together. In the rest, the yolks were free or but slightly joined, while the cicatriculæ were in most cases remote from one another. In a third of the eggs, one yolk only developed, and it was sometimes that at the "big end," sometimes that at the "little end" which failed; but the most remarkable feature was that one of the yolks had produced a double monstrosity. The remainder of the specimens showed more or less development in both yolks, and in a case where both embryos were normal, though the former were joined, the cicatriculæ were in their proper position at the north pole, as it were, of the yolk. Other examples showed one normal chick and one incompletely grown; while in one case, and this in an egg laid by the same fowl, as in the previous case of a similar character, there was one normal chick and a double monstrosity. The usual idea is that the chickens we occasionally see preserved in spirits with four wings, and as many legs, and perhaps two heads, are formed from two yolks in a single egg, which have produced a double monstrosity owing to pressure. But pressure would hardly account for such merging of two component chicks as often takes place. The researches referred to show that in two cases it was a single yolk or cell which, irrespective of the second, produced the double embryo. These particular eggs, then, show in one and the same example two kinds of twins, two young ones produced together, and one egg-cell producing two young ones.

Andrée's system of steering balloons has recently been tested by Mr. Perceval Spencer. A drag rope, five hundred feet long and about one hundred pounds in weight, was used, the balloon being fitted with a "steering sail." A *Times* reporter says that "We satisfied ourselves that to steer a balloon to some extent by this method is perfectly feasible . . . for not only can one so direct the balloon as to avoid obstacles, but the even altitude maintained by the use of the trail rope lessens the waste of gas; for it must be remembered that though the friction of the trail rope drags the balloon down, the balloon is also relieved of ballast to the extent of the rope that is on the ground—two opposing forces that tend to keep the balloon in equilibrium at a certain elevation."

According to the *Mining and Scientific Press* the following are the relative values of the rarer metals, the prices given being per one pound avoirdupois of each metal:—

Gallium	$68,600	Erbium	$3,675
Vanadium	10,780	Ruthenium	2,695
Rubidium	9,800	Niobium	2,450
Thorium	8,330	Rhodium	2,450
Glucinum	5,800	Barium	1,960
Calcium	4,900	Titanium	1,102
Lanthanum	4,900	Zirconium	1,040
Lithium	4,900	Osmium	1,040
Indium	4,410	Uranium	980
Tantalum	4,410	Palladium	560
Yttrium	4,410	Tellurium	490
Didymium	4,410	Chromium	490
Strontium	4,200	Gold	300
Arium	3,675		

Gold, therefore, is not by any means the most precious of metals, taking only the twenty-seventh place according to this list, and, weight for weight, gallium commands a price about two hundred and thirty times that of gold.

Obituary.

Mr. Latimer Clark, f.r.s., whose death occurred on Sunday, the 30th October, was a distinguished civil and electrical engineer. Born at Great Marlow, in 1822, he commenced a career of success as assistant engineer under Robert Stephenson at the building of the Britannia and Conway tubular bridges, an account of which he published some years later. In the capacity of electrical engineer he superintended the construction and laying of more than one hundred thousand miles of submarine cable in various parts of the world, and invented the Clark standard coil, as well as numerous telegraphic improvements. A joint paper by Mr. Clark and Sir Charles Bright, contributed to the British Association in 1861, was the means of putting electrical measurement on a firm basis. From suggestions made in this paper, a committee, in which Lord Kelvin was the leading spirit, evolved a rational system of electrical units—the terms "volt," "ampère," "ohm," and so on, being adopted as the result of their deliberations. Mr. Clark was also the first to introduce the pneumatic system of transmitting postal and telegraph matter. As fourth president of the Society of Telegraph Engineers (now the Institution of Electrical Engineers), in his inaugural address in 1875 he gave a valuable account of the early history of the electric telegraph. The deceased gentleman, with Robert Sabine, was joint author of "Electrical Tables and Formulæ," a standard work, and, in collaboration with the late Mr. Herbert Sadler, produced a book on "Double Stars." He was also well known as the designer of a cheap transit instrument, useful not merely as a model for teaching purposes, but as a means of determining true time. Mr. Clark was elected a Fellow of the Royal Society in 1889, and he was also a Chevalier of the Legion of Honour.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

BARRED WARBLER IN LINCOLNSHIRE.—On September 5th I shot an immature female of the Barred Warbler (*Sylvia nisoria*), at North Cotes. The bird was feeding on a bunch of brambles in a ditch not far from the coast. It was very wild, flying a considerable distance when flushed. The wind was east, very light, with fine hot weather. The only other migrants seen were a Willow-Wren and a young Spotted Flycatcher.—G. H. CATON HAIGH, Grainsby Hall, Great Grimsby.

[The Barred Warbler is an inhabitant of Central Europe. This is but the thirteenth example recorded in the British Islands, and all have been taken in autumn, from August to November.—H. F. W.]

BEWICK'S SWANS IN SUFFOLK.—On the 14th November a Bewick's Swan was shot at Benacre, Suffolk. It weighed twelve and a half pounds, and measured, flexure twenty inches, and total length thirty-six inches. Another was shot at the same place on the 31st October. They are being set up by Quatremain, of Stratford-on-Avon.—JOS. F. GREEN, West Lodge, Blackheath, 16th November, 1898.

Common Dipper at Hillington (*The Field*, November 12th, 1898).—Sir W. H. B. Ffolkes records that he shot a specimen of *Cinclus aquaticus* on November 9th, at Hillington, in Norfolk. The bird was apparently of the normal British form, and not of the dark Scandinavian form (*C. melanogaster*) which is usually found in our eastern counties in winter.

White's Thrush in Warwickshire (*The Field*, November 5th, 1898).—Mr. Peter Spicer, a taxidermist, of Leamington, reports that a specimen of *Turdus varius* has been sent to him for preservation by the Earl of Aylesford, on whose estate, near Coventry, the bird was shot in October. This Siberian Ground Thrush has been obtained a good many times in England in winter, but only once before in October.

Pectoral Sandpiper in Kent.—At a meeting of the British Ornithological Club, held on October 19th, Mr. N. F. Ticehurst exhibited a male of *Heteropygia maculata*, obtained on August 2nd last, between Lydd and Rye. This species has been observed in Great Britain more frequently than any other American species of wader, and nearly all the occurrences have been on the east coast in autumn or winter.

Eider Duck in Donegal (*Land and Water*, November 12th, 1898.)—Mr. T. A. Bond, of Londonderry, reports that a female of this bird, which is rare in Ireland, was shot on the east coast of Donegal in the first week in November.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

SUGAR-BEET INDUSTRY IN ENGLAND.

To the Editors of KNOWLEDGE.

SIRS,—In the last number of your very esteemed journal you described the efforts made this year to create an interest in the growing of sugar-beet, and for the establishing of a beet-sugar industry in this country. You had the kindness also to mention my name as being associated with this question. I supplied about four hundred farmers in England, Scotland, and Ireland gratuitously with sugar-beet seed, gave them my advice free, and have analyzed upwards of five hundred parcels of sugar-beet. These beetroots were grown almost in every county in the United Kingdom, and the result is a remarkable success, as regards weight and saccharine contents, which both exceed by far the figures received from Germany, Austria, France, etc.

You also mentioned the statements of Sir John Lawes and Sir Henry Gilbert in their pamphlet on this subject. I must say I differ in my views from these gentlemen. That we can grow better beetroots in this country than on the Continent I have distinctly proved by my extensive experiments. I have further shown that our acreage of roots is higher than on the Continent. Finally, I have proved (and letters from authorities are in my hands) that the figures given in my book "Sugar," relating to the cost of growing sugar beetroots, are exact. Facts speak best. My tabulated statement and report about my beet-growing experiments this year in England, Scotland, and Ireland will appear about the beginning of December next, and it will show conclusively that it is possible in this country—(1) to grow sugar-beetroot profitably; (2) to manufacture our own sugar from home-grown sugar-beet with great advantage, and be independent of the Continent.

SIGMUND STEIN.

THE SMELL OF EARTH.

To the Editors of KNOWLEDGE.

SIRS,—I have read with interest, though I can hardly say with conviction, Mr. Clarke Nuttall's article on "The Smell of Earth."

Can Mr. Nuttall explain the smell of damp sandstone? It is one of many phenomena, very familiar, but which appear inexplicable.

If it be alleged that the smell is not that of the stone but of the occluded gases, the difficulty is only removed one step. Again, clay has a smell of its own, and I know no satisfactory explanation of the well-known odours of iron, copper, etc.

Highlands, Putney Heath, S.W. G. B. LONGSTAFF.

[The smell of damp sandstone, has, I believe, at present received no satisfactory explanation; indeed the whole of our scientific knowledge of "Smells" is still in a very elementary stage. To say that a substance has its own peculiar smell because it gives off certain gaseous particles is, in such cases as iron, copper, sandstone, etc., merely begging the question. With reference to the smell of damp earth, the new theory is based on the researches of M. Berthelot and M. G. André, and the particular bacterium has been later identified by Herr Rullmann. Your correspondent will find more definite reference in "Technical Mycology," by Dr. Franz Lafar (tr. C. Salter), the first volume of which is already published by Messrs. Griffin & Co. (*see* "Iron Bacteria"), a second volume being still in the press.—G. C. N.]

EVOLUTION IN BIRD SONG.

To the Editors of KNOWLEDGE.

SIRS,—With reference to the interesting suggestion made by Mr. Witchell, in his article on "Evolution in Bird-song," in your September issue, that human ideas of the "crescends" in singing may possibly have been borrowed from the nightingale, it is certainly interesting to note how frequently musicians, and more especially the older clarinists, have taken their themes from birds. Thus we have "Le Coucou," by Daquin, "Le Ramage des Oiseaux,"

by Dandrieu, and "Le Rappel des Oiseaux," by Ramsau, to mention only a few examples, while many instances might be cited where bird-calls have been introduced in orchestral works. Nevertheless, in these cases, we have a direct artificial imitation of various bird-calls. It is, however, otherwise with a "nuance" like the "crescends," which, belonging as it does to musical dynamics, would scarcely require to be imitated. Rather may we surmise that this grace in singing would spring spontaneously from those physiological causes, viz., nervous energy and muscular tension, which lie at the root of all musical utterance, for, as pointed out by Herbert Spencer,* "loudness of tone, pitch of tone, quality of tone, and change of tone, are severally marks of feeling, and, combined in different ways and proportions, serve to express different amounts and kinds of feelings." W. Alfred Parr.

21, Viadella Scala, Florence.
October 22nd, 1898.

WEASEL AND YOUNG.

To the Editors of Knowledge.

Sirs,—The following is somewhat on a par with Mr. Witchell's interesting account of a weasel and her young in the November number of Knowledge. I was out with the head-keeper of a well-known shooting in Suffolk, when we came to a stream. He pointed to a jutting-out piece of bank, and said he once saw a rat (probably *M. amphibius*) dive from this spot into the water with a young one in its mouth, swim along with it under water, drag it up on to the bank, run round with it to the old spot and dive in again. This was repeated five or six times on exactly the same beat. The keeper, who is a most observant and accurate field-naturalist, thinks the old rat was teaching the young one to dive and swim.

Perhaps the young weasels mentioned by Mr. Witchell were being taught how to run. Jos. F. Green.

West Lodge, Blackheath.

To the Editors of Knowledge.

Sirs,—Referring to the letter in your last issue on a weasel leading her young, I happened recently to be in a hayfield where mowing had been going on. Noticing a bent tuft of grass I turned it up, and saw beneath it seven little stoats laid side by side—heads and tails together. Then looking about me I noticed, some half-dozen yards off, a small round hole which seemed to get larger the deeper it went into the ground. I therefore placed myself at a suitable distance to watch, and very shortly, all being quiet, the mother's head cautiously appeared outside the hole. She then came out and at once began to take hold of each little one in turn very carefully, as a dog will take a puppy, and so lead it towards and down the hole.

William C. Tetley.

MOON'S HALO.

To the Editors of Knowledge.

Sirs,—On the 26th October I was in Oxfordshire, near Wallington, and saw a wonderful double halo round the full moon. The halo immediately surrounding the moon was orange coloured, with a pinkish rim; and surrounding this inner halo was another of about the same size, of a vivid green, with a somewhat deeper reddish-pink rim. There was a "mackerel sky," but I was surprised that no storm followed the phenomena. I first noticed the halo at 11 p.m., and by 11.15 it had quite disappeared; but I am not aware when it first became visible. Speaking very roughly, I should say that each halo appeared to be about sixteen times the apparent size of the moon.

M. Cordelia Leigh.

"ASTRONOMY OF THE 'CANTERBURY TALES.'"

To the Editors of Knowledge.

Sirs,—Kindly allow me to say a few words in the way of comment upon the very interesting article by Mr. E. W. Maunder on the "Astronomy of the 'Canterbury Tales'" in your September number. In it he shows how frequently Chaucer makes allusion to astronomical matters, and points out how the detail and accuracy displayed by the poet in these allusions demonstrates a practice of stellar observation quite unusual to ordinary writers of the present day, and much less to be expected in an age before clocks and telescopes, when astronomy could hardly be called a science. Mr. Maunder attributes this exceptional knowledge of the poet to a much more general practice of observing the heavenly bodies, together with the popularity of the Universities at the time, diffusing its knowledge more widely than subsequently ruled. It seems to me that he has overlooked the chief reason for Chaucer's familiarity with the movements and altitude of the sun and other heavenly bodies. He undoubtedly had in continual use an astrolabe, by which he could tell the time either by the sun or stars of the first magnitude. He could carry the instrument about, and by making observations with it for the many purposes it could be applied to, he would be continually familiarising himself with the angular height of sun and stars, and associating the length of shadows with the time calculated. His astrolabe would not only give him this information, but also showed the sun's position on the ecliptic for each day of the year, as well as the degree in the zodiacal sign the sun would be at the time of observation, besides other matters of purely an astrological import for which the astrolabe was essential. The numerous and varied circulations that could be made with this instrument are shown in the treatise Chaucer wrote on the astrolabe for the use of his son "Lowys." He called it "Bread and Milk for Children," but it would require a very intelligent child to become master of all the problems he sets therein, with the help of the book and instrument alone. Seeing, then, the constant use Chaucer must have made of the astrolabe, his knowledge of the sun's longitude day by day throughout the year does not strike one as so "strange and unusual" as the writer of the article states it to be. Again, regarding the many times and varied circumstances Chaucer makes use of astrologic lore in his works, it seems somewhat doubtful if he had been able to shake off the fascination that study had for so many men of learning of his time (not to mention its almost universal influence among the uneducated), although no doubt he treated with scorn and contempt most of the absurd pretensions of the professors of that art.

Torquay. H. J. Lowe.

[I fear that in Mr. Lowe's desire to show his acquaintance with the astrolabe he has missed the intention of my paper. My point was simply to show that in Chaucer's day, actual observation—in a certain direction—of the heavenly bodies was more general then than now. The question of the instrument then in use did not enter into the case, and does not in the least affect it. Chaucer's Treatise on the Astrolabe is, of course, sufficiently well known, but I was not dealing with it, but with his unequalled gallery of photographs of the general public of his time, which he gives in the "Canterbury Tales."

* "Principles of Ethics," Vol. I., p. 248.

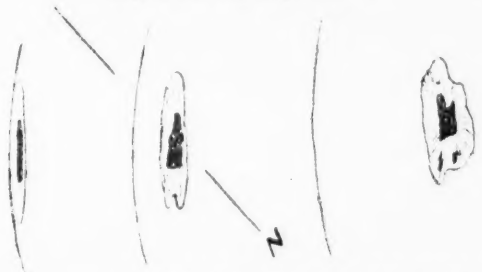
I differ from Mr. Lowe as to Chaucer's own belief in astrology. He writes of it in detail, as I showed. But I think he no more believed in it than did Flamsteed, who yet drew a horoscope to determine a fortunate hour for founding Greenwich Observatory, or Sir Walter Scott, who yet showed a perfect acquaintance with its principles in "Guy Mannering."—E. WALTER MAUNDER.]

THE GREAT SUN-SPOT.

To the Editors of KNOWLEDGE.

SIRS,—With reference to Mr. Maunder's interesting article on this subject in the October number, I beg to send you enclosed a drawing I made of the spot when very near the Sun's eastern limb, September 2d. 6h., and other drawings September 3d. 2h., and September 4d. 1h., all G. M. T.

Sunspot in 3*f* edge. Power 120.
Edge of Sun cuts the penumbra?



Sept. 2nd, 1 p.m. Sept. 3rd, 9 a.m. Sept. 4th, 8 a.m. 1898.

They were taken with a four-inch equatorial and a solar prism, and are therefore subject to the inversion peculiar to such prisms; this may be rectified by viewing the reflection of the drawings in a looking-glass. The power used was one hundred and twenty. The last drawing by mistake makes the spot a little too short.

Jamaica, MAXWELL HALL.
October 24th, 1898.

VARIABLE STARS.

To the Editors of KNOWLEDGE.

SIRS,—I think there is no real point in dispute between me and Col. Markwick, but I may perhaps suggest that some variables may be really of the eclipse-type, though not usually so classed.

If the obscuring body is a close satellite and the obscured star is very distant, the position of the earth in its orbit would practically make no difference in the phenomena. But suppose that the obscuring body is a very distant satellite, or belongs to a different system, but happens to be almost in the direct line between the earth and the bright star, the amount of obscuration might depend on the earth's position in its orbit, and the period of the variable star would be very nearly one year. Now, as a matter of fact, the number of variable stars with a period of nearly one year seems larger than chance will account for. Is the excess due to this cause?

With ordinary eclipse-variables we may expect, on the tidal theory, a slow increase of the period, accompanied by a slow diminution in the amount of the variation. But at the same time the movements of the sun and the star through space would probably render the eclipse either more or less central and thus complicate the phenomena.

Whether the cause which I have suggested will afford the true explanation of what I may call annual variables, will I think chiefly depend on the result of observations as regards their spectra at different periods.

W. H. S. MONCK.

VARIABLE STARS IN GLOBULAR CLUSTERS.

By Miss AGNES M. CLERKE,

Author of "The System of the Stars," "A Popular History of Astronomy during the Nineteenth Century," etc., etc.

GLOBULAR clusters are, perhaps, the most fascinating of telescopic objects. Their silver radiance delights the eye; the mystery of their constitution allures thought. What, we instinctively ask ourselves, is the reality corresponding to the strange and beautiful appearance of "balls of stars"? Are the luminous particles composing them *suns* in any true sense? What are their mutual relations? Is their aggregation destined to be permanent? Do they form stable systems, or merely temporary societies undermined by forces tending towards dissolution? Some indications on these points have been gathered, but definite information is still to seek. Only within the last few years, indeed, have the objects in question been brought within the scope of organized research.

There need be no hesitation, however, in affirming that swarming stars belong to the same cosmic family as solitary stars—that they are spherical masses of intensely heated matter, radiating into space by means of suitably adapted photospheric apparatus. But they are unlikely to be *solar* suns. Many are sensibly, probably all are sub-sensibly nebulous. They stand, then, presumably at an earlier stage of development than our own luminary, and may be greatly less dense proportionately to their brilliancy. The nature of their spectra ought here to prove of decisive import. Too dim for separate examination, they, nevertheless, reinforce each other sufficiently, where the stars run together in the central "blaze," to give intelligible results with powerful appliances. The early efforts to obtain them, made by Sir William Huggins and Dr. Vogel, at a time when no adequate means were available, can now at last be carried out with good promise of a successful issue.

In our present ignorance of their distance from the earth we are unable to determine the scale of these jostling suns. A rough calculation, however, shows that an enormous remoteness would correspond to standard—that is, to solar light-power.

The grand southern cluster ω Centauri has been thoroughly investigated from one hundred and fifty negatives taken at Arequipa. Prof. Pickering may well call it "the finest in the sky." He adds that it lies just within the border of the Milky Way, and appears to the naked eye as a hazy star of the fourth magnitude. It has a diameter of about forty minutes. Over six thousand stars have been counted on one of the photographs, and the whole number is much greater.* If we assume it to be seven thousand, then the average lustre of the *particles* contained in a single *drop* of light equivalent to a fourth-magnitude star comes out at 13·6 magnitude. But our own magnificent orb, actually of minus 25·5 magnitude (according to Pickering's estimate), if removed so far as to have a parallax of only one-hundredth of a second, would still take eleventh stellar rank. Only a remoteness three-and-a-third times greater still, implying a light journey of over eleven hundred years, could render it faint enough to pass in the crowd of the assemblage in the Centaur. The possibility that it may be plunged thus deep in the void cannot be gainsaid, since the spatial unit fixed by measurements of the parallactic pendulum-swing of the nearer stars has yet to be applied to the galactic world in all its length and breadth; but, as Kepler said, "the pill is a big one to swallow."

* Harvard College Observatory Circular, No. 33.

The mechanical arrangements of globular clusters entirely baffle our narrow conceptions of what is feasible and workable. Instead of the neatly finished aspect betokening orderly revolution round an attractive centre, they present, very commonly, ravelled edges, a radiated conformation, and dark vacancies of curiously definite shapes. An *escape of stars* is strongly suggested; and the conjecture might even be hazarded that the removal of stellar material thus effected is the immediate cause of the inward dilapidation manifestly progressing in visibly tunnelled spheres. The two symptoms indeed appear to be correlated. Three imposing groups—M 13, in Hercules, M 3, in Canes Venatici, and M 5, in Serpens, may serve as examples. All have curvilinear appendages, and all show pierced, and, as it were, excavated interiors. On the other hand, ω Centauri and 47 Toucani, an exquisite ornament of the southern pole, are compact within and without. No perforations are visible in them, and on Bailey's plates they came out almost perfectly circular. Here the twofold marks of dissolution are together absent, as in other cases they are together present.

By far the most remarkable discovery, however, yet made about globular clusters is that about one in five of them are literally crammed with variable stars. Their abundance is such, that as many as a hundred—in Prof. Barnard's words*—"have been found in a space in the sky that would be covered by a pin's head held at the distance of distinct vision." The pictures affording this wonderful revelation were taken at Arequipa, with the thirteen-inch Boyden telescope, an instrument rendered available for either visual or photographic employment by the adjunct of a reversible crown lens. Its fine qualities are not allowed to "rust" in disuse. Hundreds of exposures, from one up to six hours in duration, have been made with it for the purposes of this special enquiry, the results of which have been published in successive "Harvard Circulars." They are most nearly complete for ω Centauri. In this cluster, out of about three thousand stars accessible to separate study, no less than one hundred and twenty-five proved markedly, and, for the most part, very rapidly variable. A large majority, in fact, run through their changes in less than twenty-four hours. The periods of one hundred and six have, so far, been ascertained; only eight among them exceed a day's length, while three fall short of seven hours. One of these belongs to No. 91 of the blinking battalion, which, springing up to a maximum once in six hours and eleven minutes, is at present the quickest of known variables. U Pegasi, until lately the claimant of that distinction, is outrun by many components of clusters.

As will be seen by referring to Circular No. 33, printed in abridged form lower down, Prof. Pickering divides the short-period variables in ω Centauri into four classes, distinguished by the forms of their light-curves. The first largely predominates. The objects constituting it increase with extreme swiftness, and decline by comparison slowly. No. 45, for instance, with a period of 14h. 8m., sextuples its brightness in a single hour, and that on the clock-stroke, all these stars being characterized by exemplary punctuality; in other cases the rise may be still more rapid, but closer inquiry is precluded by the needful duration of photographic exposures.

Some of the ω Centauri variables show humped light-curves, indicating abortive secondary maxima, like those of δ Cephei and η Aquilæ; and one exceptional case has been noted, in which the rule of an ascent quicker than the descent is reversed.

* See his recent admirable address on "Astronomical Photography," p. 26.

Besides ω Centauri, three stellar globes—M 5, M 3, and M 15—have yielded a copious harvest of rapidly-changing stars. The first includes about nine hundred components that can be individualized and watched; eighty-five among them are conspicuously variable. Two were visually discovered as such by Mr. David Packer, of Birmingham, in 1890. They have been identified by Prof. Barnard as Nos. 42 and 84 of the Harvard register, and might be called companion objects, since each alike fluctuates to the extent of a magnitude and a-half in a period of twenty-six days. Dr. Common, about the same time, obtained photographic indications of variability throughout the cluster*; but so delicate an enquiry could scarcely be

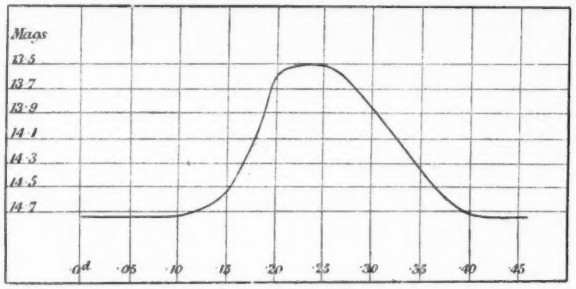


FIG. 1.—Light-Curve of No. 18 Messier 5.

prosecuted under the muffled skies of Ealing. The perfect conditions at Arequipa were indispensable to success—a success enhanced by Prof. Barnard's confirmatory work with the forty-inch Yerkes refractor. "These cluster variables," he remarks,† "seem to form a distinct class from the ordinary variable stars. It is very interesting to watch one of them in a powerful telescope, and to see with what quickness it passes through its light-variation. One of the small stars in M 5, whose period is 12h. 31m., seems to be dormant for a large part of the time, as a very faint star, invisible in ordinary telescopes. It begins to brighten, and in two or three hours has risen nearly two magnitudes, and faded again to its normal condition; while another and larger star, quite near it, seems to require a month or more to go through its light fluctuation."

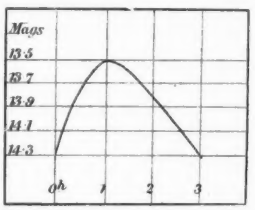


FIG. 2.—Maximum of No. 12 Messier 5. A long minimum is indicated.

Most of the eighty-four variables in M 5 are doubtless of the type dominant in ω Centauri. They traverse their cycle in a few hours, ranging through a couple of magnitudes by very unequal gradations. From a datum-level of obscurity, they spring up almost suddenly, and with the regularity of a flash-light, then sink back at a more leisurely rate. The stationary intervals apparent to the eye are, however, shown photographically to be marked by the progress of slow variation. Absolute pauses are short and rare. No. 18, of which the light-curve is given in Figure 1, illustrates the peculiarities of the class. Its period is 11h. 7m. 52s., its limiting magnitudes 13·5 to 14·7. Probably no other star equally faint has been pursued throughout its phases. During nearly five hours it remains semi-extinct, but needs no more than an hour and quarter for a triple gain of light, which it

* *Monthly Notices*, Vol. L., p. 517; *Nature*, Vol. L., p. 448.

† *Astr. Nach.*, No. 3519.

loses again in about four hours.* Figure 2 represents the maximum of No. 12 in this cluster. The further sections of its curve appear to include a protracted minimum, but had not been traced out at the date of publication. A specific resemblance is evident between Nos. 18 and 12, as between Nos. 42 and 84.

Prof. Barnard was greatly struck, in the course of his scrutiny of M 5, with a number of "inky black spots" near, but not in its densest parts, recalling the analogy of the model northern cluster, M 13 Herculis. Even the minor group is described as "a gorgeous object," faintly visible to the naked eye,† with a *gross* diameter, so to speak, of about nineteen minutes of arc.‡

M 3, the beautiful radiated star-throng in Canes Venatici, contains the largest proportion of variables of any cluster yet examined. One in seven—one hundred and thirty-two in all—of the nine hundred components separately discernible on the Arequipa plates fluctuate extensively. Their laws of change, however, have received up to the present only preliminary attention. The same may be said of the fifty-one variables in M 15. This is a cluster in Pegasus, considered by Dr. Roberts to be strongly nebulous. The stars, moreover, imprinted on a negative taken November 4th, 1890, exhibit an arrangement "in curve lines, and patterns of various forms, with lanes or spaces between them."§

The absence of variables from most globular clusters accentuates the wonder of their abundance in others. Nor is it possible to discover any corresponding differences of state or aspect. Thus in 47 Toucani, an exact analogue on a slightly reduced scale of ω Centauri, the causes of variability seem to be strictly localized. A *nest* of six changing stars was at once brought to light by comparisons of Prof. Bailey's plates, but none are scattered at large through the assemblage, which is otherwise made up of perfectly stable components. Still more remarkably, only two out of two thousand stars rigidly tested in the great Hercules globe have proved variable, and that to an insignificant extent; whereas nearly one per cent. of the visible populace of heaven shine more or less unsteadily. Now, this last cluster is not only generally nebulous, but many of its outlying members are separately provided with luminous appendages; so that the disconnection of nebulosity from variability in light, already tolerably obvious, is, by these fresh experiences, emphatically re-affirmed. Another fact of interest, albeit likewise of negative import, is that M 80, the cluster in Scorpio illumined in 1860 by the blaze of a "new star," is exempt from the slightest suspicion of actual variability. Nor has the phenomenon been met with in any "irregular" group, such as the Pleiades, the "Beehive," the chromatic cluster about κ Crucis, or the blazonry in the sword-handle of Perseus.

To what, then, can it be ascribed? Prof. Pickering makes the "provisional" suggestion that the key to the enigma may be found in the relation to the line of sight of a common plane of revolution, axial or orbital. Irregular collections, in this view, possess no such fundamental plane; while spherical assemblages show effects of variability depending upon its approach to coincidence with our visual ray. The hint is of tempting significance; it opens up possibilities of insight into cluster-mechanism such as might have been deemed desperate of attainment from any other point of view. Yet there are fatal objections to its unconditional adoption. It implies two rationales of stellar variability—the spot-theory, and the eclipse-theory. In the first, the period is determined by the rotation of a single body, in the second, by the mutual revolutions of a pair. Bodies variable through axial movement are necessarily assumed to be brilliant on one side, comparatively obscure on the other. Piebald suns, however, may be dismissed from consideration as mere mathematical postulates. They serve conveniently as the basis of formulæ, but lie apart from physical reality. A degree of interior mobility, indeed, utterly inconsistent with the presence of fixed dark areas, is indispensable to the maintenance of *white* radiation. For it must be remembered that these clustered stars are unvarying in their variability. They do not brighten unawares, or casually "hide their diminished heads." The phases of each are settled once for all by unalterable law.

The eclipse-hypothesis of short-period variability stands on a very different footing. There is at any rate good reason for holding stars of the δ Cephei class to be genuine spectroscopic binaries, with synchronizing light-and-motion periods. But no agreement between their epochs of minimum and of possible eclipse has been established, to say nothing of other glaring incongruities and improbabilities. In addition, eclipsing couples of the authentic Algol stamp *are not forthcoming among aggregated stars*. Yet they should, on the geometrical theory, abound and super-abound. Their apparent absence must be accounted for in any plausible speculation as to the causes of variability in globular clusters.

VARIABLE STARS IN CLUSTERS.

CIRCULAR No. 33 of the Harvard College Observatory deals with the results of a systematic search by Prof. S. I. Bailey for variable stars in globular clusters. The whole number of stars examined was nineteen thousand and fifty, of which five hundred and nine are variable. This amounts to one variable in thirty-seven stars, or nearly three per cent. It does not follow, however, that clusters in general contain more variable stars than occur elsewhere, for, if we except the four clusters, ω Centauri, Messier 3, Messier 5, and Messier 15, which together contain three hundred and ninety-three variables, an average of seven per cent., the remaining nineteen clusters have one hundred and sixteen variables among thirteen thousand three hundred and fifty stars, or less than one per cent. There is a very striking difference between the results obtained in clusters equally rich in stars, as, for example, between Messier 13, the great cluster in Hercules, where an examination of one thousand stars shows two variables, one in five hundred; and Messier 3, where, among nine hundred stars, one hundred and thirty-two are variable, one in seven. A common plane of revolution, orbital or axial, of the different systems or individuals of star clusters, and the relation of that plane to the line of sight, might provisionally be suggested as a possible explanation.

The periods and light curves of several variables in other clusters have been determined, but the study of those in ω Centauri is well advanced. This cluster may be called the finest in the sky. It lies just within the borders of the Milky Way. There are no bright stars near. To the naked eye it appears as a hazy star of the fourth magnitude. It has a diameter of about forty minutes. The brightest individual stars in this region are between the eighth and ninth magnitude. Over six thousand stars have been counted on one of the photographs, and the whole number is much greater. Only about three thousand,

* The co-ordinates are given by Pickering in *Astr. Nach.*, No. 3354.

† R. Sprague, "Popular Astronomy," Vol. I., p. 408.

‡ Barnard, *Astr. Nach.*, No. 3519.

§ "Photographs of Star-Clusters and Nebulæ," p. 119.

however, are sufficiently bright and well separated to serve for comparison in the discovery of variables. Of these three thousand, one hundred and twenty-five are variable. One hundred and fifty photographs of the cluster have been taken with the thirteen-inch telescope, and already ten thousand measures have been obtained, about half of which have been made by Miss E. F. Leland.

Although the results are at present provisional, it is not probable that the final results of the discussion will materially alter the conclusions. Of the hundred and six variables in ω Centauri whose periods have been determined, ninety-eight have periods less than 24h. The longest period is that of No. 2, 475d., the shortest that of No. 91, 6h. 11m. Three have periods less than 7h. Of the eight having periods of more than 24h., two have periods between one and two days, two between two and three days, one of four days, one of fifteen days, one of one hundred and fifty days, and one of four hundred and seventy-five days.

The largest range in variation is about five magnitudes, and no star has been included whose light changes do not amount to half a magnitude.

The light curves of the ninety-eight stars whose periods are less than twenty-four hours may be divided into four classes. The first is well represented by No. 74. The period of this star is 12h. 4·3m., and the range in brightness two magnitudes. Probably the change in brightness is continuous. The increase of light is very rapid, occupying not more than one-fifth of the whole period. In some cases, possibly in this star, the light remains constant for a short time at minimum. In most cases, however, the change in brightness seems to be continuous. The simple type shown by No. 74 is more prevalent in this cluster than any other. There are, nevertheless, several stars, as No. 7, where there is a more or less well marked secondary maximum. The period of this star is 2d. 11h. 51m., and the range in brightness one and a half magnitudes. The light curve is similar to that of well-known short-period variables as δ Cephei, and η Aquilae. Another class may be represented by No. 126, in which the range is less than a magnitude, and the times of increase and decrease are about equal. The period is 8h. 12·3m. No. 24 may perhaps be referred to as a fourth type. The range is about seven-tenths of a magnitude, and the period is 11h. 5·7m. Apparently about sixty-five per cent. of the whole period is occupied by the increase of the light. This very slow rate of increase is especially striking from the fact that in many cases in this cluster the increase is extremely rapid, probably not more than ten per cent. of the whole period. In one case, No. 45, having a period of 14h. 8m., the rise from minimum to maximum, a change of two magnitudes, takes place in about one hour, and in certain cases, chiefly owing to the necessary duration of a photographic exposure, there is no proof, at present, that the rise is not much more rapid.

The marked regularity in the period of these stars is worthy of attention. Several have been studied during more than a thousand, and one during more than five thousand periods, without irregularities manifesting themselves.

A few words may be added in regard to the kind of clusters in which variables have been found. Up to the present time they have not been found in any except dense globular clusters, of which Messier 3, Messier 5, and the great cluster in Hercules may be taken as examples. The number of such clusters within the reach of ordinary instruments is not great. Of the clusters given in the table, N. G. C. 104, 362, 5139, 5272, 5904, 6093, 6205, 6266, 6626, 7078, and 7089, may be described as highly condensed; 1904, 5986, 6397, 6656, 6723, 6752, 6809, and 7099, as moderately condensed; and 3293 and 4755, as open clusters. 869 and 884, the clusters in the sword-handle of Perseus, are little more than regions relatively rich in stars.

The first group, of eleven highly condensed clusters, having a total of eleven thousand nine hundred and eighty stars, has four hundred and sixty-two variables, or one in twenty-six. The second group, of eight moderately condensed clusters, has forty-six variables among four thousand seven hundred and forty-one stars, one in one hundred and three. The two open clusters furnish no variables, and the region of three square degrees around N. G. C. 869 and 884 only one.

Thus far the only regions which are found to be especially rich in variable stars are condensed clusters, but even here only in relatively few cases. These dense clusters are commonly called globular, and many of them are such. In some cases, however, as ω Centauri, the form is somewhat elliptical.

N. G. C. 6266 is the most striking example of a highly condensed cluster which is irregular in form. This irregularity is intensified in the distribution of the variables. The cluster is much compressed on the south side. For a distance of one minute from the centre the distribution of the stars seems to be about equal, but if a line be drawn east and west through the centre, and the stars within one minute of this line are omitted, there are two hundred and fourteen stars south, and three hundred and fifty-four stars north, within four minutes of the central line. In this cluster are twenty-six variables, of which nineteen are north of the central line, and seven south. Excluding those within seventy inches, there are fifteen north, and only one south.

BOTANICAL STUDIES.

VII.—ABIES.

By A. VAUGHAN JENNINGS, F.L.S., F.G.S.

THE results of our study of the mode of reproduction and life-history of Selaginella (KNOWLEDGE, November, 1898) may be shortly recapitulated as follows:—The plant bears two kinds of sporangia (*macrosporangia* and *microsporangia*) instead of only one, as in the Ferns, and these contain two kinds of spores (macrospores and microspores); the large spores *seem* to give rise to the new plant but only by means of an excrescence of tissue which proves to be the representative of the Prothallus or Oöphyte of the Fern, here reduced, colourless, rootless and dependent on the spore; that this protuberance contains true, but rudimentary, Archegonia, the egg-cells of which are fertilized by spermatozoids developed from the microspores, which also show a tendency to form a still more rudimentary prothallus.

In passing on to the Mountain Pine, the *Abies excelsa* which clothes the slopes of our European mountains, we are crossing a great gap in the series of plant types: and yet, while we do not know the forms which bridge the gulf, once more the use of patience and a microscope has shown how these widely different types can be compared, co-related, and brought into line with the other plants we have been examining.

In botanical classification the gap we are crossing is that between the *Cryptogamia* and *Phanerogamia*. All the types we have so far studied belong to the former division. The name suggested itself to the early naturalists as one to express the fact that the lower plants have no conspicuous "flowers" such as characterize the majority of the higher forms.

If we take the term Phanerogamia to mean the higher plants, in which the organs of reproduction are readily distinguishable, we may again make two series:—The *Gymnosperms*, in which the seeds are not enclosed in a special case, and the *Angiosperms*, in which they are so protected. Our pine-tree belongs to the former section, and the flowering plants to the latter.

Among the Gymnosperms are included three groups:—The strange *Gnetaceæ* (with the *Ephedra* recalling a "horse-tail," and the weird *Welwitschia* of African deserts, reminding us of nothing but a certain coal-fossil), which we cannot now dwell on; *Cycads*, the beautiful feathery tropical plants recalling the tree ferns in growth, which we must refer to later on; and *Conifers*, including the firs, pines and larches, the yew, the cypress and the juniper.

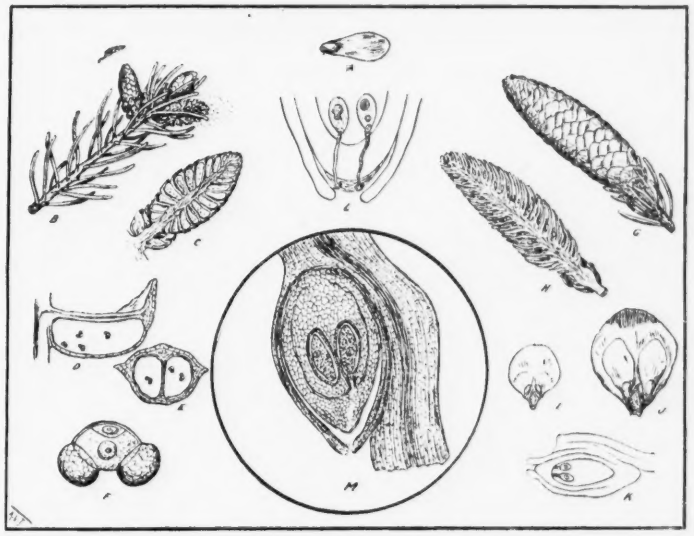
Restricting ourselves to our type, and omitting all details as to the structure of the vegetative part of the plant, we start with the fact that the pine is a woody exogenous tree, with persistent narrow leaves, and a fructification in the form of *Cones*.

A cone is only a prolongation of the axis of a branch bearing numerous closely-crowded leaves which differ from other leaves in form, and carry the reproductive organs. The cone-leaves, or "*scales*," are in fact *sporophylls* just as much as those of the Selaginella spike, but are more closely set and more specially modified for their particular function. In the species of the *Selaginella* we examined we found that in the same cone similar leaves might bear different kinds of spore cases; *Macrosporangia* containing four large *Macrospores*, or *Microsporangia* with a number of little *Microspores*, also in groups of four. In the pine we find the difference carried a step further; these two kinds of spores are developed on distinct cones.

In *Abies excelsa* the young shoots in the early spring bear groups of small cones (one-half to one inch long) of a yellow-white colour. A section with a knife along one of these shows that each of the close-set scales carries on its under side a double sporangium, filled when ripe with pale yellow dust. This dust consists of "*pollen-grains*," or *Microsporangia*. The quantity produced is incredible, and at the time of ripening the air of the pine woods is full of it, blowing in golden clouds before the slightest breeze. The grains may fall so thickly as to cover the surface of lakes in the neighbourhood, and may be carried enormous distances by the wind.

The reason for the great buoyancy of the pine pollen will be found on examining some under the microscope. The main part consists of a mass of protoplasm, covered by a firm wall, but this is expanded at two points into a pair of large inflated wings, forming round chambers containing air. Examination with a higher power and suitable staining will show that the spore does not consist of a single cell. There is a portion cut off from the rest by a curved wall, and each part contains a nucleus. In other words, before the germinating activity of the pollen-grain has commenced, it has a tendency, however slight, to form a cell tissue, in fact, a "prothallus," as we found to be also the case, in a somewhat greater degree, with the microspore of Selaginella.

Turning to the female cones, which are larger and of a deep red colour when young, we find that if one of the scales is stripped off, it will be found to bear at its base, on the upper or inner side, a pair of pale oval bodies, which are the *macrosporangia* or *ovules*. In scales from ripe cones these have become seeds, and each has a membranous "wing," which assists its carriage by wind as do the air-sacs of the pollen-grain. One cannot, however, see much resemblance between these ovules and the Selaginella macrosporangia, and there is no sign of the contained



A.—Seed of *Abies excelsa*. B.—Fertile branch of the same plant bearing male cones. C.—Longitudinal section through one of the cones, showing the Microsporangia on the under sides of the Microsporophylls (leaves of the cone). D. E.—Longitudinal and transverse sections of a Microsporophyll, showing the double Sporangium on the under side of the leaf, with Microspores in the cavity. F.—A Microspore ("pollen-grain") highly magnified. The central portion contains Protoplasm, and the nucleus which is subsequently active in fertilizing the egg-cell. The small cell cut off above is the vegetative cell representing the Prothallus, and the rounded side outgrowths are the accessory air-chambers that assist in dispersion of the pollen by wind. G. H.—Fertile branches bearing female cones, from the outside and in section. I. J.—Scales of the cones in young and older stages, seen from the inner side. Each carries a pair of ovules at the base. K.—Diagrammatic section through a scale and its ovule, showing the Integument, Micropyle, Nucellus, Embryo-sac, and Archegonia. L.—Diagrammatic section of the apex of an ovule showing the same structures, with pollen-grains seated on the nucellus, and sending down their tubes to the Archegonia. M.—Longitudinal section of the base of an ovuliferous scale, drawn from an actual preparation, showing the same structures, and the course of a pollen tube.

macrospores. If any such correspondence is to be established, it must be done by cutting thin sections through them, longitudinally, and as near the middle plane as possible, for microscopic examination. What we find then, is that the whole is composed of a soft cellular mass, which, however, can be seen to consist of different tissues.

The outer layers form a covering (*integument*) to an inner oval cell-mass, the *nucellus*; but at the lower extremity the integument is absent, leaving a little round gateway, the *micropyle*. Lying in the nucellar tissue is, again, an elongated structure, the *embryo-sac*, which represents a macrospore. It develops within itself, even at an early stage, a cellular tissue, called the *endosperm*, which may be compared with the prothallus tissue of the Selaginella macrospore. When we examine the dark bodies lying near its lower end, we find in each a large, nucleated *egg-cell*, or *oösphere*, with a group of small cells at the apex, that may well represent the neck-cells of an *archegonium*.

XUM

The only question remaining is whether this series of comparisons is supported by observations on the subsequent history of the different parts.

When one of the pollen-grains, which are blown in countless numbers round the cones, comes to rest at the micropyle of an ovule it adheres there owing to the presence of mucilaginous material at the apex of the nucellus, and its activity commences. While the small cell which we regarded as representing a rudimentary prothallus remains passive, the other throws out a tube which grows down through the nucellar tissue toward the archegonium. The protoplasm passes down with the growing tube, and finally, when the latter reaches the archegonium, the active nucleus of the microspore passes into the protoplasm of the egg-cell, fuses with its nucleus, and thus forms the compound nucleus from which the new plant subsequently arises.

We may, then, regard our comparison between the embryo-sac and pollen-grain of the pine with the *Macrospore* and *Microspore* of *Selaginella* as proved, and we see that in spite of the great gulf between Cryptogams and Phanerogams we can still trace the continuity of the organs and processes of reproduction.*

VIII.—LILIUM.

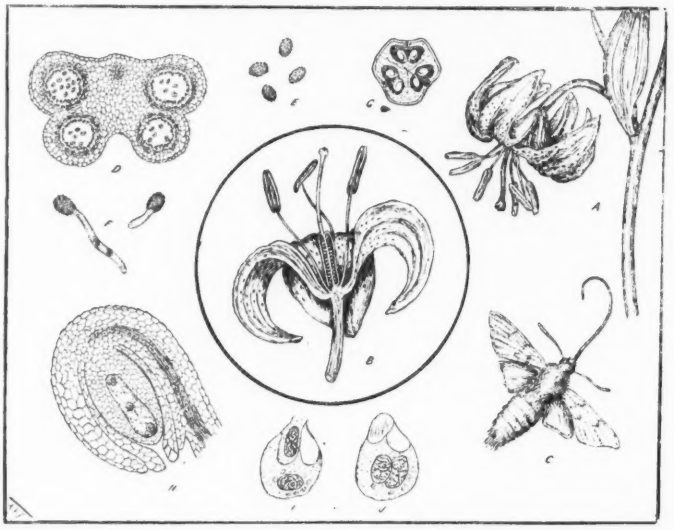
In conclusion, it will be our work to examine the corresponding parts of a typical flower and see if we can carry the series of comparisons yet a step further and bring the highest representatives of plant life into line with their lower and earlier relatives.

The one chosen for illustration here is the Mountain Lily (*Lilium martagon*). The specimens were collected in July, at a height of between six thousand and seven thousand feet in the Eastern Alps, and the moth is drawn from a specimen taken in the same locality, though not actually seen visiting the flower.

We noted that the Pine belonged to the *Gymnosperms* or naked-seeded plants, because the ovules and seeds are carried on the free surface of scales and not enclosed in a special case. The Lily, on the other hand, belongs to the *Angiosperms*, because the ovules and seeds are contained within the walls of an enclosing "ovary." It is, however, the possession of a "flower" which one naturally regards as the distinctive feature of the Angiosperms, and we have to ask at once, what is a flower, and what parts of it, if any, correspond with the structures we have seen in the Pine or in Selaginella?

We may regard a flower as a shortened axis bearing whorls (or spirals) of leaves, the upper of which are modified in connection with the essential organs of reproduction, and the lower specialized for purposes accessory to the process. If we imagine a pine cone shortened, its upper scales bearing ovules, those below pollen-sacs, and the lowest become barren, expanded, soft, and green or coloured, we should have (details apart) the structural plan of a flower. It would be impossible to say why the lower leaves should become so altered if we knew nothing of the relationship between flowers and insects. Though almost everyone has now a general idea of the important part played by insects in securing the cross-fertilization of plants, yet few recognize that the attraction of insects is, biologically speaking, the reason for the very existence of true flowers. The pine tree casts its myriad spores to the wind and has no need of petals to its cones, and in the same way the wind-fertilized angiosperms bear small and inconspicuous flowers without a coloured perianth. Fertilization by this method is uncertain, and an immense amount of pollen has to be produced. With the greater certainty attainable through the agency of insects there is greater economy, but the plant must make its flowers attractive, and often form those curious devices and traps to make the insect do its work, the study of which forms so fascinating a chapter in biological study. In our mountain lily the plant's assistant seems to be usually a day-flying moth, *Macroglossa stellatarum*, known in Switzerland as the "Taubenschwanz" or "pigeon-tail." There are nectaries or honey-glands at the base of the perianth, and a long fold or half-closed tube leads to them along the middle of the petals. The moth, hovering below the flower, has to pass its long tongue down this tube in its efforts to get at the honey, and in doing so becomes dusted over by the shaking anthers above with the pollen, which it afterward carries to another flower.

We must, however, put aside the moth and the petals



A.—Flower of *Lilium martagon* (drawn from a specimen collected in July near Davos Platz). B.—Median vertical section of the same, showing (*a*) three of the Perianth Leaves; (*b*) three of the *Microsporophylls* (*stamens*); (*c*) the three united *Macrosporophylls* (*carpels*), constituting the ovary in the centre, prolonged above as the style with its terminal stigma. Growing on the central axis of the ovary are the rows of *Macrosporangia* (*ovules*). C.—*Macroglossa stellatarum*, the Moth which effects the cross-fertilization of the plant (drawn from a specimen taken in the same locality). D.—Transverse section of the *Microsporangium* (*anther*), with *Microspores* (*pollen-grains*) developing in the four chambers. E. and F.—Microspores (pollen-grains) at rest and in germination; in F observe the presence of three nuclei. G.—Transverse section of the Ovary, showing the Macrosporangia (ovules) growing from the central axis formed by infolding of the edges of the Macrosporophylls (carpels). H.—A longitudinal section of a Macrosporangium (ovule), showing the two coats separated at the apex to form the *Micropyle*, the central tissue of the *Nucellus*, and the *Macrospore* (embryo-sac) enclosed in it. In the latter are seen, at the lower (apical) end, the *egg-cell* with its two *synergids* (the group representing an archegonium); in the centre the nucleus of the embryo-sac, and at the opposite pole the *antipodal cells*. I. J.—The end of the pollen-tube coming in contact with the egg-cell, showing the fusion of the sperm-nucleus of the former with the germ-nucleus of the egg-cell. [I J, after Strasburger. The rest original.]

* The recent discovery that in some Cycads and in the "Gingko" ("Maidenhair tree") the contents of the pollen tube actually form ciliated motile spermatozoids, is of the greatest value in bridging this gulf, and one of the most striking results of detailed microscopic study.

and the picturesqueness, and settle down to work on the essential parts of the flower.

First, the *Stamens*. The two anther-sacs with their yellow dust-like pollen recall at once the pollen-sacs of the pine, and if we were right in regarding those as microsporangia, there is no reason why we should not use the same term here. The stamens are, in fact, "*microsporophylls*," or microspore-bearing leaves; the anthers, *microsporangia*, and the pollen-grains *microspores*. Thin transverse sections of the anther can be easily made for the microscope, and there is no difficulty in observing the two-layered wall, and the four enclosed chambers.

In ripe anthers the chambers will contain loose pollen-grains, but in those in the immature stage, the pollen-grains will be seen developing in groups of four by the division of a single "mother-cell," thus resembling the microspore formation in Selaginella. The ripe pollen-grains appear to consist of a single cell, and if they are stained and mounted, it will be found that such is the case; but there are *two nuclei*, a fact of great interest when we remember that the pollen-grains of the pine had also two nuclei, one of which was contained in a special cell, separated by a wall from the rest of the cell-contents. This we regarded as equivalent to the group of cells in the Selaginella microspore, a rudimentary male prothallus. Here, though no cell-walls are formed, we cannot help looking on the second nucleus as the last relic of the vanished prothallus.

The apical part of the flower we find occupied by an elongated, slightly three-sided structure, the *ovary*. A cross-section of this shows it to contain three chambers, each with a double row of ovules growing from the central column formed by the meeting of the three division walls. Though it may not appear so at first sight, the whole is really composed of three specialized leaves, the *carpels* or *macrosporophylls*. If we imagine a scale like that of the pine cone to bear a row of ovules along each side-margin and then to be folded down the middle so as to bring the two rows of ovules together, a single-chambered ovary would be formed such as is seen in a pea-pod. If, however, there were three carpels placed like the sides of a triangle, and these were all similarly folded, with the inturned walls in contact, a three-chambered ovary like that of the lily would result. The carpels are, in fact, sporophylls, each with a row of macrosporangia along the margins, and the three compacted together in this manner form the ovary.

By cutting a number of sections across the whole ovary it is probable that one of the six possible ovules in each slice will be cut near the middle plane, and the following structures can then be observed.

There is a central tissue mass, the *nucellus*, but it is enclosed in this case by a *double integument* which is absent at the apex, leaving, as before, a little passage or *micropyle*. As in the pine, also, there is a large oval *embryo-sac* or *macrospore*, lying in the nucellus; but here we find important differences between the present type and the conifer. Instead of containing a mass of cells, the "prothallus," the sac here contains protoplasm, with large fluid "vacuoles." A large nucleus will be seen near its centre, and there is a group of three round nucleated cells at each end of the sac. The group of three, at the end furthest from the micropyle, called the "*antipodal cells*," must be regarded as the last trace of a prothallus tissue. The group at the opposite pole consists of two small cells side by side, close to the apex of the macrospore, and below the micropyle; and a third larger cell below them. Its position would suggest that it corresponds to the *egg-cell* of the pine-ovule, and observation of the fertilization process proves this to be the case. During this process the two smaller cells, or *synergids*, are inactive, and they seem to have no special duty to perform, so that we are perhaps safe in regarding them as the last relics of the neck of an archegonium.

When the pollen-grains have become attached to the stigma they throw out *pollen-tubes*, which grow down through the tissues of the style till they reach the neighbourhood of the ovules, and their tips pass through the micropyle. The end of the tube at this stage may be seen to contain two or three nuclei, but it will be found that only one of these is the fertilizing agent. When the end of the tube is in contact with the macrospore its end wall is absorbed; the active, or sperm-nucleus, passes in and fuses with egg-nucleus, but the other nuclei in the pollen-tube remain passive. This, of course, tends to support the view that they represent the merely vegetative cells of the ancestral prothallus.

After fertilization the embryo-sac becomes filled with a tissue of cells serving for nourishment for the embryo plant, and this tissue is known as the *endosperm*. From its formation at this stage, however, it is evidently a different thing from the endosperm in the pine, which is the macrospore-prothallus.

At this point we must leave the story of the lily, as the subsequent divisions of the compound nucleus, and its gradual growth into an embryo in the seed, and finally into a new lily-plant, are all matters apart from our special purpose.

What we have found is that by a careful study of the minute details of the flower we can prove the presence there of parts corresponding to those observed in the higher flowerless plants. We have found that even in the highest plants we can trace the relics of that "alternation of generations" which is so characteristic of the life-history of the moss and the fern. Though, from the moss upward, through the series of types we have studied, the Sporophyte stage has become ever more and more predominant, and the Oöphyte stage ever less and less, the microscope shows it to be still there though hidden away among the secrets of the ovule and the pollen-grain.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

NEW COMET.—Mr. W. R. Brooks, of Geneva, N.Y., discovered a pretty bright comet in the constellation Draco at R.A. 14h. 35m. 10s., Dec. + 60° 26′ on the evening of October 20th. It was moving rapidly to the S.E., and after travelling through Hercules, crossed the equator on November 17th, and reached its perihelion six days later. The comet appeared to be about 4′ or 5′ in diameter, with very decided central condensation, and about equal to a star of seven and a-half magnitude. There is no reason to suppose that the orbit deviates sensibly from a parabola. During the first half of December the comet will be situated in the north-western borders of Sagittarius, and its apparent motion will have become very slow. The following is an ephemeris by Möller of Kiel for Berlin mean midnight:—

Date. 1898.		R.A. h.	m.	s.	Declination. °	′	Distance in millions of miles.	Brightness.
December	1	18	15	45	−11	51·0	141	0·3
,,	3	18	16	37	−13	7·1	145	0·2
,,	5	18	17	22	−14	19·7	150	0·2
,,	7	18	18	2	−15	28·4	154	0·2
,,	9	18	18	37	−16	33·9	158	0·2
,,	11	18	19	10	−17	36·3	161	0·2

XUM

Denning's Comet (1881 V.).—In *Ast. Nach.*, 3524, Dr. Berberich gives a sweeping ephemeris for this comet, which is computed to return to perihelion on February 10th, 1899. The conditions are, however, unfavourable to its observation, for it will necessarily be extremely faint, and only discernible in some of the large telescopes employed in our chief Observatories. On December 6th the comet will be in about R.A. 286·5°, Dec. −27° or 31° east of the sun, and much too near that luminary to allow of its detection.

The November Leonids of 1898.—November weather in the English climate is proverbially bad, but it is seldom that the skies are so clouded and so thoroughly unfavourable for observation as they proved between November 8th and 15th in the present year. It is doubtful, therefore, whether the Leonid shower has been successfully observed anywhere in England. On November 13th and 14th dense fogs prevailed in many parts of the country. At the time of writing (November 15th) reports have only been received from a few stations, but these are of a disappointing character. At Bristol the sky was pretty constantly obscured either by cloud or fog during the whole of the second week of the month, and the only suitable opportunity for securing an observation occurred on the morning of November 13th after 3 a.m. Meteors were, however, by no means frequent on that occasion, only seven being observed in an hour, and the Leonids were not represented amongst them. At 4h. 4m. a.m. a brilliant flash lit up the sky, and was probably due to the outburst of a very large meteor, but the observer was watching the eastern region from an open window, and the flash evidently had its origin in the opposite quarter. Mr. H. J. Townsend, writing from Leeds, says that the Leonids were lost in the fogs which enveloped that district just at the important time, and Mr. W. E. Besley makes a similarly unfavourable report from Middlesex. On the night of the 10th, however, at 11h. 29m., he saw a swift, streak-leaving meteor, about equal in brightness to Sirius, passing from 98°+45° to 63½°+47°. This may possibly have been a Leonid, though its direction of flight was from a point several degrees below the radiant in the "Sickle." Two minutes later he registered a meteor of mag. 1½, shooting to just S. of β Aurigæ from a radiant S. of θ Ursæ. Should the bad weather have negatived the efforts of English observers generally, it is still satisfactory to think that the atmospheric conditions on the Continent and in America may have been more favourable. We shall look forward with interest to descriptions of the shower as witnessed at these distant places. It would be a matter for great regret if the Leonids came and went without being adequately recorded.

Meteoric Shower on September 25th, 1898.—M. A. Hausuy, of the Observatory at Meudon, near Paris, writes that four persons belonging to the Society for the Navigation of the Air noticed that shooting stars were surprisingly frequent on September 25th, 1898. They were first noticed at 9 p.m., when they were appearing at the rate of one per minute. The numbers afterwards increased, until at 2 a.m. on the morning of September 26th the maximum was reached, the rate being three or four per minute. The moon was ten days old at the time and shining brightly; the meteoric shower must therefore have been of very special character to have asserted itself in the strength assigned. From the indications afforded by the paths, M. Hausuy says the radiant was probably situated in Triangulum.

Large Meteor.—The Indian papers contain accounts of a fireball seen at Calcutta and other places on the evening of October 4th at 6h. 20m. It moved very slowly from W.S.W. to E., and it occupied about 10 seconds in its long horizontal flight. It was five or six times as bright as Venus. Another account from Calcutta says the meteor passed from S.W. by W. to N.E., lighting up the whole face of the Esplanade and Government House almost as brightly as an electric search-light. The nucleus emitted a sapphire-blue colour, but its material prior to vanishing became red. The meteor was noticed at Sitarampur, two hundred and forty miles from Calcutta, travelling from S.W. to N.E. It was obviously a fine object of its class, and one of those slow-moving fireballs directed from radiants in the western sky.

The Geminids.—This well-known annual shower will recur on December 10th to 12th, and there being no interference from moonlight it ought to be very favourably observed. It does not, like the Leonids and Andromedes, occasionally present very imposing spectacles, but it is more frequent in its apparitions, and will sometimes furnish thirty or forty meteors in an hour.

THE FACE OF THE SKY FOR DECEMBER.

By A. Fowler, F.R.A.S.

Solar activity continues to furnish surprises for those who make regular observations, notwithstanding that the minimum of sunspots, under normal conditions, is so near. The Sun will be at its least distance from the earth on the **31st** at 10 P.M. On the **13th** there will be a partial eclipse of the Sun, but, as it will not be visible in this country, particulars are considered unnecessary.

Mercury is an evening star in the early part of the month, arriving at greatest eastern elongation (21°) on the **4th**. He is, however, too low for observation in our latitudes. He will be in inferior conjunction on the **21st**.

Venus will be at inferior conjunction with the Sun on the **1st**, and will afterwards be a morning star. On the **17th** she will rise about two hours before the Sun. She will be stationary on the **21st**.

Mars rises soon after 8 P.M. at the beginning of the month, and about 6 P.M. at the end. He is a conspicuous object in Cancer, and, as will appear from the diagram of his path given in the October number, his motion will be direct until the **10th**, when he is stationary, and afterwards retrograde. His apparent diameter increases from 11·2″ on the **1st** to 13·8″ on the **31st**, and his horizontal parallax from 10·6″ to 13·1″.

Jupiter is a morning star. During the month he traverses a direct path in the following part of the constellation Virgo. Towards the end of the month he will rise shortly before 3 A.M.

Saturn may be considered not observable this month. He will be in conjunction with the Sun on the **6th**, and will afterwards be a morning star.

Uranus is a morning star, rising about two hours before the Sun towards the end of the month.

Neptune may be observed during the whole of the night. He will be in opposition on the **15th**, and on that date will be about 50′ north of ζ Tauri.

Conveniently observable minima of Algol will occur on the **7th** at 11.54 P.M.; on the **10th** at 8.43 P.M.; on the **13th** at 5.32 P.M.; and on the **30th** at 10.25 P.M.

Mira Ceti may, perhaps, continue as a naked eye star throughout the month.

The Moon will enter her last quarter on the **6th** at 10.6 A.M.; will be new on the **13th** at 11.43 A.M.; enter her first quarter on the 20th at 3.22 A.M.; and will be full

on Tuesday, the **27th**, at 11.39 P.M. On the **27th** she will be totally eclipsed, and the following data may be useful:—

	h.	m.	
First contact with shadow ...	9	47·8	G. M. T.
Beginning of totality ...	10	57·4	,,
Middle of totality	11	42·1	,,
End of totality	12	26·8	,,
Last contact with shadow ...	13	36·4	,,

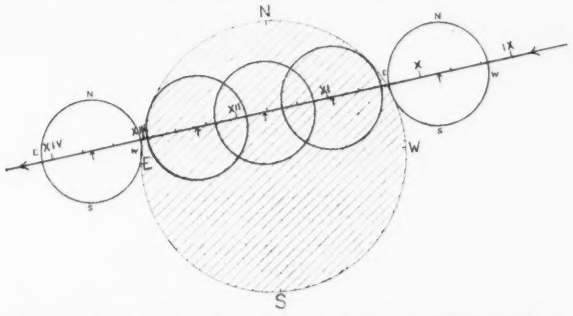


Diagram showing the path of the Moon through the Earth's Shadow, December 27th.

The first contact on the Moon's limb is at an angle of 112° from the north point towards the east, and the last at 95° towards the west. The magnitude of the eclipse, that is, the distance at mid-totality from the Moon's most immersed limb to the boundary of the shadow nearest to the opposite limb, divided by the Moon's diameter, will be 1·383. The eclipse is illustrated in the above diagram, showing the part of the shadow traversed by the Moon, and indicating also the points of contact and the times of occurrence of the principal phases. During the eclipse there will be occultations of sixteen stars, ranging in magnitude from 8·7 to 9·5, for which particulars will be found in the "Companion to the Observatory."

On the **29th** there will be an occultation of ζ Cancri, the disappearance taking place at 10.1 P.M., 92° from the north point (130° from the vertex); and the reappearance at 11.16 P.M., 303° from the north point (334° from the vertex), reckoned through east.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and posted on or before the 10th of each month.

Solutions of November Problems.

No. 1.

(By A. C. Challenger.)

1. Q to Kt7, and mates next move.

No. 2.

(By P. H. Williams.)

1. B to K5, P to Q3.
2. Q to QB7, P×B.
3. Q to B3, P to K5.
4. B to Q3, P×B (or A).
5. Q to Bsqch, R to Kt8.
6. Kt to B6, R×Q mate.

(A.)

4. P to K6.
5. Q to Bsqch, R to Kt8.
6. R to K2, R×Q mate.

CORRECT SOLUTIONS of No. 1 have been received from H. S. Brandreth, G. G. Beazley, W. de P. Crousaz, D. R. Fotheringham, H. Le Jeune, J. M'Robert, A. E. Whitehouse, W. Clugston.

J. M'Robert.—Received solution too late to acknowledge last month.

Alpha.—The reply to 1. Q to B6 is Kt to Kt7, a cleverly provided defence. The Indian puzzle which you send is very pretty, but it has become evident that our solvers will not attempt anything longer than a three-move problem.

G. F. T., and *W. B. Stead.*—If 1. Q to B3, K×R, and there is no mate.

N. E. Meares.—We insert your 3-move problem below.

Mr. Bolton's 11-move mate is too long for this column.

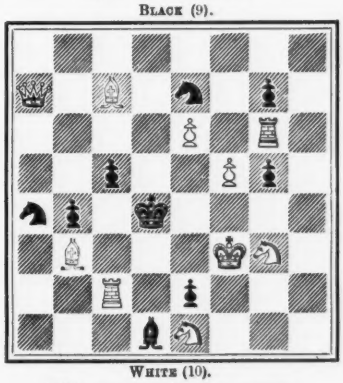
[With regard to problem No. 2, our worst fears have been realized. It is evident that the readers of KNOWLEDGE are not attracted by sui-mates, and they will not be published in future. At the same time we may quote the opinion of the best problem judges to the effect that there is more scope for originality in the sui-mate than in the direct mate. Every possible phase of the latter has now been exhausted.]

PROBLEMS.

No. 1.

By F. W. Andrew.

BLACK (9).



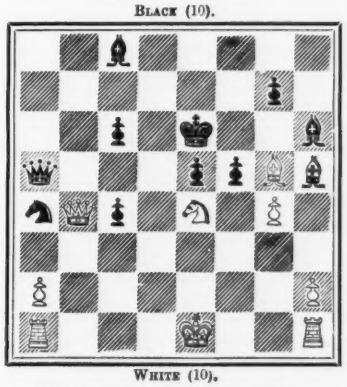
WHITE (10).

White mates in two moves.

No. 2.

By N. E. Meares.

BLACK (10).



WHITE (10).

White mates in three moves.

[We consider it advisable to state that Castling is allowed in this problem; also that the key-move is a check. In spite of this the problem is well worth trying, some of

the mates being very pretty. The composer is anxious to know whether any of our readers have ever seen the *fourfold* idea carried out: *i.e.*, a position similar to the above, but containing the second move R to KBsq, which he has failed to get. Solutions of this problem will not be considered correct unless White's second moves are given correctly in every case.]

The following game was played at the Craigside Tourney last winter. The notes indicated by letters are by Mr. Bellingham; those referred to by numerals are by the Chess Editor.

"Queen's Gambit" Declined.

WHITE. (E. Macdonald.)	BLACK. (C. Y. C. Dawbarn)
1. P to Q4	1. P to Q4
2. P to QB4	2. P to K3
3. P to K3	3. Kt to KB3
4. Kt to KB3	4. P to QB4
5. Kt to QB3	5. Kt to QB3
6. B to Q3	6. B to K2
7. Castles	7. P to QR3 (*a*)
8. P to QKt3	8. Kt to QKt5 (*b*)
9. B to K2	9. QP×P } (1)
10. KtP×P	10. BP×P }
11. P×P	11. Castles
12. Kt to K5!	12. Kt to B3 (2)
13. Kt×Kt	13. P×Kt
14. R to Kt1	14. P to B4 (3)
15. P to Q5	15. P×P
16. P×P	16. Q to Q3 ? (*c*)
17. P to KKt3 (*d*)	17. R to R2 ?
18. B to KB4	18. Q to Q2
19. P to Q6	19. B to Q1
20. B to B3	20. B to Kt2
21. B×B	21. R×B
22. Q to B3 (4)	22. B to Kt3
23. Kt to R4!	23. KR to Kt1
24. Kt×B	24. R×Kt
25. R×R (5)	25. R×R
26. Q to R8 check	26. Kt to K1 (*e*)
27. R to K1	27. K to B1
28. B to K3 (6)	28. R to B3 (*f*)
29. B to Kt5!	29. R to B1 (7)
30. Q×P	30. P to KB3
31. B to B4	31. R to Kt1 (8)
32. R to Q1 (9)	32. P to Kt4
33. B to K3	33. R to B1 (10)
34. Q×R (*g*)	34. Q×Q
35. P to Q7	35. Q to Q1
36. B×Pch	36. K to B2
37. B to Kt6	37. Q×B
38. P Queens	38. Resigns.

NOTES.

(*a*) Threatening 7. . . . P×BP; 8. B×P, P to QKt4; 9. B to K2, P to B5, with a majority of Pawns on the Queen's side.

(*b*) Premature.

(1) The question whether the double exchange of Pawns is good in such positions has never been definitely settled. White is generally left with a centre somewhat difficult to protect, but gains freedom for action in compensation. In the present position, Black, having already wasted a move, should certainly avoid opening the game.

(2) The Knight should at least wait to be driven. The exchange not only leaves Black with an isolated Pawn, but blocks his open QB file. I should suggest instead 12, . . . Kt to Q2.

(3) Black should retain his command of the point at his Q4. He might try 14. . . . Q to R4, 15, B to Q2, B to Kt5.

(*c*) We prefer . . . B to B4.

(*d*) An exceedingly powerful reply, which gives White a winning advantage.

(4) White's conduct of all this part of the game is quite in the best style. Every move tells.

(5) In such a position the more pieces there are exchanged on the Queen's side the better White is pleased.

(*e*) If 26. . . . Q to Ksq, White wins by 27. Q×Qch, Kt×Q; 28. P to Q7.

(6) If 28. R to K7, Q to B3 threatening mate.

(*f*) Of course if 28. . . . Q or R×P, White replies B×P! Also if 28. . . . Q to B3, 29. Q×Q, R×Q; 30. P to Q7 as before (Ch. Ed.).

(7) For if 29. . . . R to Kt3 (or 29. . . . P to B3, 30. R to K7 wins). 30. R to K7, Q to B3, 31. Q×Q and wins.

(8) Probably with some idea of getting a mating position if White proceeds with R to K7.

(9) Anticipating Black's next move.

(10) 33. . . . Kt to B2 would lose on account of 34. Q to R7, afterwards taking the Pawn.

(*g*) A beautiful sacrifice which decides the game.

[Mr. Macdonald's play in this game certainly does not account for his low position in the tourney score.

Mr. Steinitz might have played this game.]

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